AGRICULTURAL ENGINEERING

MAY • 1955

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Farm Machinery Designers Rapidly Expanding Use of Strain Gages and Stresscoat

•

Rapid Method for Evaluating the Efficiency of Spraying and Dusting Applications

•

Engineered Farm Equipment Revives Practice of Green Feeding of Livestock

•

Engineers Develop Ridge Farming to Protect Soil from Water and Wind Erosion

•

Determination of Pressure Patterns for the Radial Flow of Air in Grains

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Truly Amazing in Design ...without Peer in Performance

Yes, the all-new Case "400" stands as symbol of what advanced engineering can achieve . . . of how engineering vision transforms itself into practical reality . . . and brings farming of the future into beneficial focus today. Truly, the 4-plow "400" is just such a creation . . . one that is breath-taking in its two-tone beauty . . . and literally "out of this world" in functional features.

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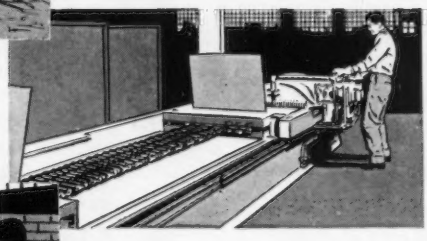
CHAIN is important to the good name of your machine...

ANY SHORTCOMING in machine performance —whatever the cause—reflects on the maker. That's why so many farm machinery manufacturers standardize on Link-Belt chain for long life and added dependability. Exact manufacturing controls and thorough testing assure maximum chain strength and uniformity . . . contribute to the overall quality of your machine.

so it's good business to rely on LINK-BELT

COMPLETENESS ASSURES LOW-COST, PRACTICAL ANSWERS. With Link-Belt's broad lines of chain, sprockets and attachments, farm machinery manufacturers are sure to find the right answer for each application.

EXPERT ENGINEERING AND FIELD TESTING. Link-Belt's engineering staff is unequalled in ability and experience. Design innovations are continually recommended and thoroughly field-tested. Many universally-used chain developments were born at Link-Belt.



ACCURATE MANUFACTURE. In the world's largest chain plant — modern, specialized machines allow the economies of large-scale production without sacrificing accuracy. In addition, continuous inspection safeguards tolerances and finish of every length of chain. Next time you face a drive or conveying problem, call your nearest Link-Belt office.

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AGRICULTURAL ENGINEERING

Established 1920

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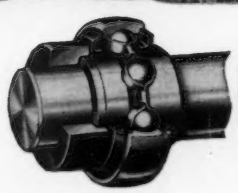
FAFNIR WIRELOC BEARING that simplifies designing by eliminating the need for housing shoulders.

FAFNIR LOW-COST PRESSED STEEL LINE of ball bearing power transmission units. Flangette illustrated.



FAFNIR-ORIGINATED WIDE INNER RING BALL BEARING with Self-Locking Collar. Easiest of all to install.

...turning points to improved performance

More opportunities to make use of anti-friction bearings accounts in no small measure for the popularity of FAFNIR with leading manufacturers of farm tractors and equipment. Through important developments in ball bearings such as the wide inner ring bearing with self-locking collar, the Wireloc radial bearing, the Flangette, these manufacturers have found economical and efficient "turning points to improved performance" for their equipment. What's more, they have become better acquainted with other FAFNIR FEATURES including . . . (1) the wide range of ball bearing types and sizes in the FAFNIR line, (2) the uniformly-high quality standards for every product, (3) the FAFNIR "attitude and aptitude" . . . a way of looking at bearing problems from the designer's viewpoint, and the ability to come up with the right bearing for the job. Are *you* taking advantage of these benefits? The Fafnir Bearing Company, New Britain, Conn.

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MOST COMPLETE LINE IN AMERICA

Modern manure spreaders are p. t. o. driven through

BLOOD BROTHERS Jointed Drive Lines

for better control . . .
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better crop returns . . .

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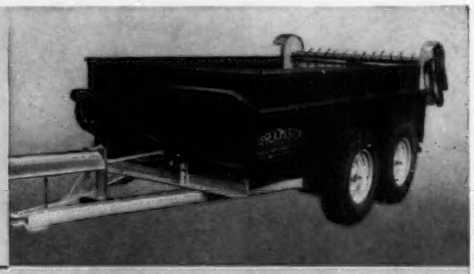
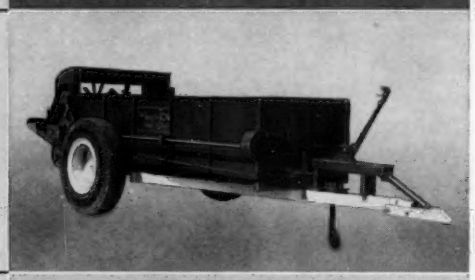


United Implements Inc.



The Farmhand Company

Kelly-Ryan Company

Compared with older drive mechanisms, the modern p.t.o. powered manure spreader provides easier operator control, for more even spread of volume desired at various speeds. And in designing these up-to-date spreaders, each implement builder logically specified Blood Brothers Universal Joints and Drive Lines.

As the "Standards of the Industry," they assure the trouble-free, long-lasting service that farmers expect.

FOR FARM IMPLEMENTS, MORE BLOOD BROTHERS UNIVERSAL JOINTS ARE USED THAN ALL OTHER MAKES COMBINED.

also The Cobey Corp. (not shown).

TAKES POWER AROUND CORNERS

BLOOD BROTHERS MACHINE DIVISION

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UNIVERSAL JOINTS AND DRIVE LINE ASSEMBLIES

A quick check of the local library is sure to reveal that new volumes are constantly being added to those shelves that hold the success books. For success, as you know, is quite the popular subject. And worthwhile, too.

But even though the thousands of published formulas for success, stretched end to end, would reach from here to Utopia, and although all of them differ to a greater or lesser degree, each inevitably includes one basic ingredient. We'll call it *Element "X."*

Element "X" is that intangible *extra* which one receives in the way of reward in certain endeavors. It's a reward that is over, above, and in addition to any material recompense, a reward that is peculiar in that it can't be given or infused but must be created and absorbed out of the undertaking itself.

Element "X" is the personal satisfaction one always derives from an occupation in which he contributes not only to his own improvement but also to that of his neighbors.

There exist many fields from which this important ingredient may be drawn, not the least of which is the farm equipment industry. And throughout the John Deere organization, people are daily experiencing this great satisfaction, knowing that in supplying the farmer with quality farm equipment, they are themselves contributing to a healthier, happier people, a better nation, and a better world.

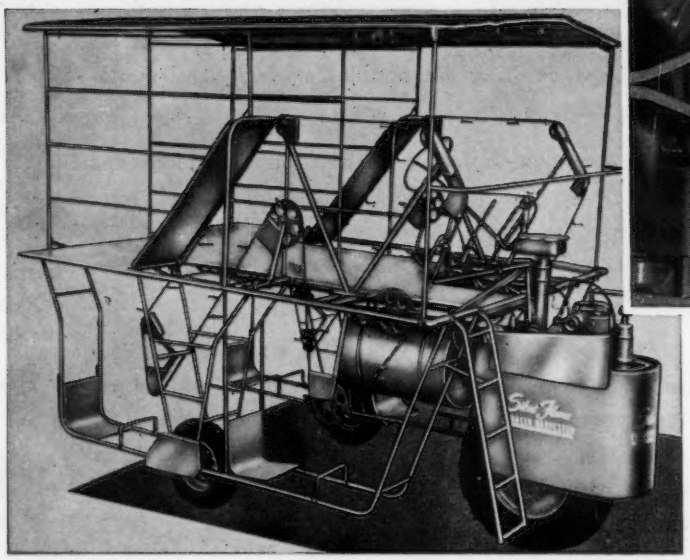
That's *Element "X."*

JOHN DEERE • Moline, Illinois

Quality Farm Equipment Since 1837

Revolutionary Harvester Triples Worker

The Tobacco Harvester above was converted for a crew of nine by adding side platform extensions for two extra loopers. When harvesting tobacco, four primers, two seated below the platform on each side, select and pull the ripe leaves from the stalk and insert them in bundles in leaf holders on conveyors. The conveyors take the tobacco to the platform where four loopers, two on either side, remove the tobacco bundles from the holders and tie them on sticks. The driver guides the harvester and places the sticks at the back of the platform.



Designed for both small and larger tobacco growers, Long's Tobacco Harvester incorporates many new features that add to simplicity, ease, safety and economy of operation. These include larger bus-type steering wheel, easy-to-turn steering gear, engine switch and throttle control on steering post, self-starter and improved heavy duty brakes. Extra equipment is also obtainable for transplanting, crop dusting and spraying right from the harvester.

Implement Photos courtesy of Long Manufacturing Co., Inc.

Output, Slashes Costs for Tobacco Growers!

New Tobacco Harvester, developed by Long Manufacturing Co., Inc., Tarboro, N. C., employs Dayton V-Belts 100% to gain maximum efficiency, low cost operation.

Harvests up to 1200 sticks of tobacco per day

Now, with Long's self-propelled Silent Flame Tobacco Harvester, seven workers can harvest up to 150 sticks of tobacco per hour, 1200 sticks per day, thanks to this remarkable, mobile harvester. This is more than *three times* the average number of sticks harvested per day by the old, antiquated way!

Cuts harvesting costs by over 50%

Besides tripling the productivity of each worker and reducing labor costs by 50% or more, the Silent Flame effects other savings by the elimination of the need for mules or horses, tobacco slides or trucks, looping racks and working shelters required by the old method.

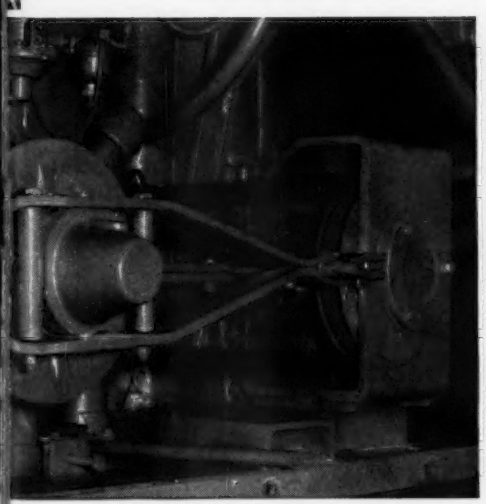
Separate ground and conveyor speeds

Extremely economical to operate, the harvester travels at a speed of ⅛ to ¼ miles per hour along the row or up to 20 miles per hour to the unloading facilities. A variable speed drive makes it possible to increase the ground speed of the harvester without increasing the speed of the V-Belt driven conveyors which carry the tobacco from pickers below to the workers above the platform.

V-Belt drive problem solved

In developing this ingenious harvester, Long Manufacturing experienced belt slippage and breakage in the early stages. To solve this problem and achieve maximum efficiency and low cost operation, Long, like many other implement designers and manufacturers, enlisted the aid of Dayton Agricultural Engineers. The Dayton Cog-Belt* was recommended as the answer and proved so successful that Dayton V-Belts and Dayton Cog-Belts are now 100% standard equipment on all Long Manufacturing Co. implements of every kind.

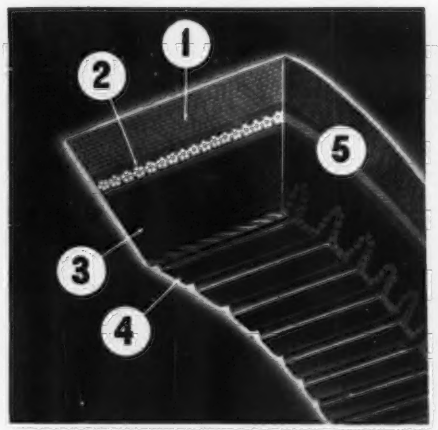
Dayton Agricultural Engineers welcomed the opportunity to assist Long Manufacturing Co. in the solution of this drive problem and will be equally glad to help you improve your V-Belt power transmission systems. Write to: Dayton Rubber Co., Agricultural O.E.M. Div., Dept. 404, 1500 S. Western Ave., Chicago, Ill.



▲ Dayton Cog-Belt provides continuous, trouble-free, economical power transmission from the engine to the variable speed drive. Daytons give peak performance and eliminate slippage because they make perfect rubber-to-metal contact, are oil resistant and offer greater strength, flexibility and heat dissipation. As a 100% Dayton user, Long employs standard Dayton V-Belts for another power application on this harvester.

The Dayton Cog-Belt . . . made only by Dayton . . . is the ultimate in V-Belt design, construction, and performance.

1. Tension section bends easily, won't crack.
2. Load carrying section has great strength, won't stretch.
3. Patented Stiflex composition prevents squashing, buckling, binding.
4. Preformed cogs flex uniformly . . . an exclusive Dayton feature.
5. Smooth, die-cut sides assure positive grip, full power.



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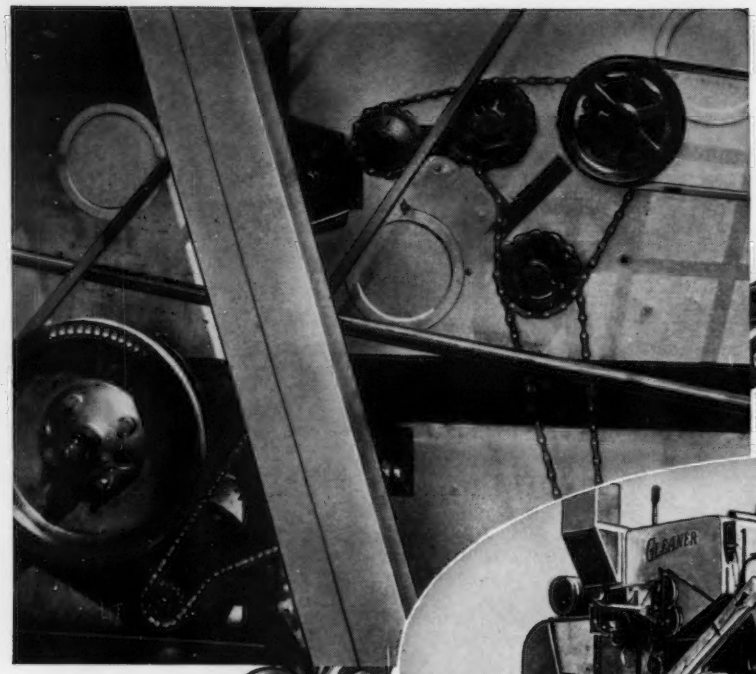
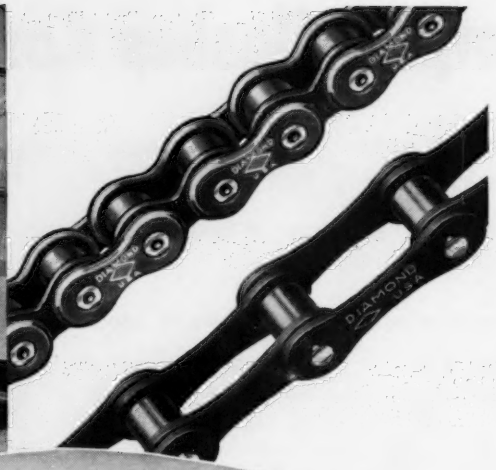
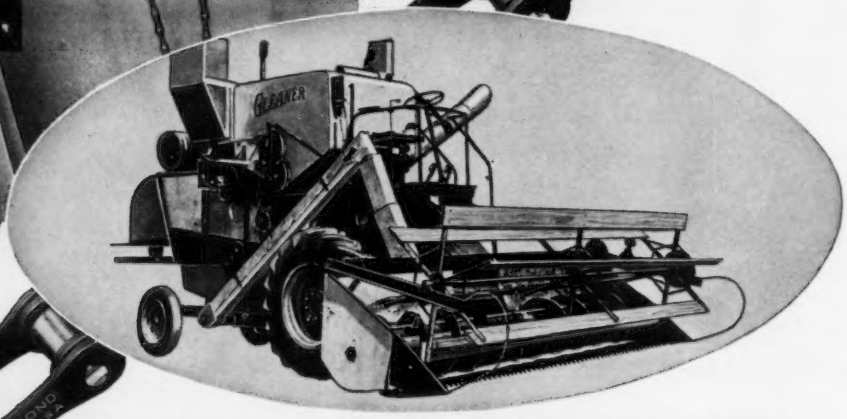
First in Agricultural V-Belts
Agricultural Sales Engineers in Chicago, Moline, New York, San Francisco, Atlanta and St. Louis







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DIAMOND CHAINS

HAVE SERVED DEPENDABLY

Over 30 years of experience is packed into the design and construction of the 1955 Allis-Chalmers line of Gleaner-Baldwin Combines.

Along with new advantages of easier operation, finger-tip controlled variable speeds, and many other outstanding design features—tried and true materials and parts are used in their construction.

Diamond Chains have earned their spot on these improved machines through many, many years of unexcelled field performance. Machinery designers and builders recognize the value of their long-life dependability, uniformity of quality, great reserve strength and high power transfer efficiency. Practical recommendations by our experienced engineering staff can help you.

ALWAYS PRELOADED

For many, many years, Diamond Chain has been preloaded after assembly for the purpose of bringing pin-bushing seating into stabilized relationship prior to field installation.

SHOT-PEENING SINCE 1944

Diamond Chain has long recognized that certain types of internal stressing of chain parts would increase fatigue resistance. To this end, link plates have been specially processed and chain rollers and other parts have been shot-peened since 1944.

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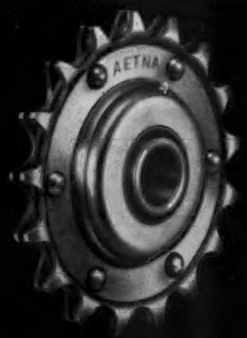


SPROCKET IDLER UNIT

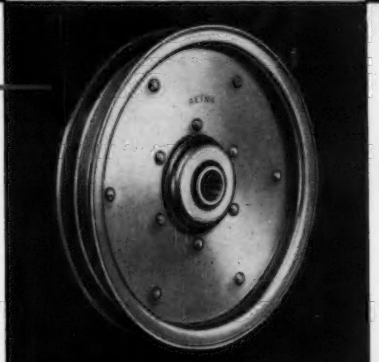
The nation's FIRST ball bearing sprocket idler. A rugged, low-cost *package* unit sized for ⅜" mounting bolts; with teeth to fit standard roller and detachable link chain. Permanently lubricated bearing has full complement of ⅜" balls for greater load capacity. 4-point ball contact for greater rigidity.

DISC HARROW UNIT

Here is anti-friction efficiency wrapped in a husky, compact, easy-to-install *package* — job-fitted to the farmer's dirtiest work. With its exclusive, superior seals; full complement of ⅜" balls and case-hardened races it assures exceptional shock load and life capacity—needs no costly upkeep.

BELT IDLER UNIT

With simple engineering changes this *all-in-one* bearing and idler can be adapted to new designs or current models . . . of combines, balers, harvesters, pickers, elevators, etc. Mounts on ⅝" bolt. Case-hardened sheaves are available with either V or flat belt grooves—in standard section V-belt sizes.



GRAIN DRILL UNIT

This and all other Aetna farm equipment bearing units incorporate "king-size" lubricant chambers, factory-packed with long-life, water resistant lubricant. This feature, combined with Aetna's advanced sealing principle, frees the farmer of troublesome, costly lubrication chores. Made to order in ½" or ⅝" shaft sizes.

only Aetna offers you all of these

THRIFTY WAYS

ADAPTER UNIT

This inexpensive multi-purpose unit can be easily and quickly mounted wherever shafts can be supported — on sheet metal or any other semi-rigid structural members. Sealed bearing is self-aligning, has eccentric self-locking collar with set-screw. Made to order in 5 shaft sizes ⅞" to 1¼".

TO IMPROVED FARM EQUIPMENT DESIGN AND PERFORMANCE

Here is added evidence that *the Aetna way* is *the thrifty way* to fight friction on the farm. For in this new line of inexpensive bearing units you see an achievement in quality manufacture which meets the long-felt economy needs of both maker and user of agricultural equipment. Each unit incorporates a single-row ball bearing featuring extreme simplicity, extra large lubricant capacity and an exclusive, remarkably effective sealing principle. All are constructed as complete *package* units—a design which not only provides functional advantages but also meets the easy-handling quick-installation "musts" of modern mass assembly methods. Rugged, compact and pre-lubricated, they assure the farmer long, dependable anti-friction performance without troublesome servicing. They "write" a new cost-cutting, problem-solving story that will interest you. Mail handy coupon below.

Aetna

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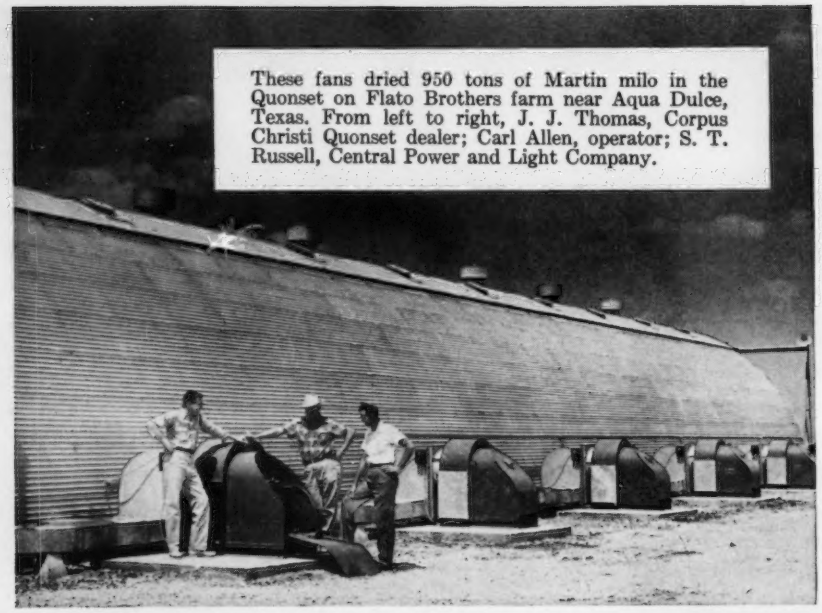
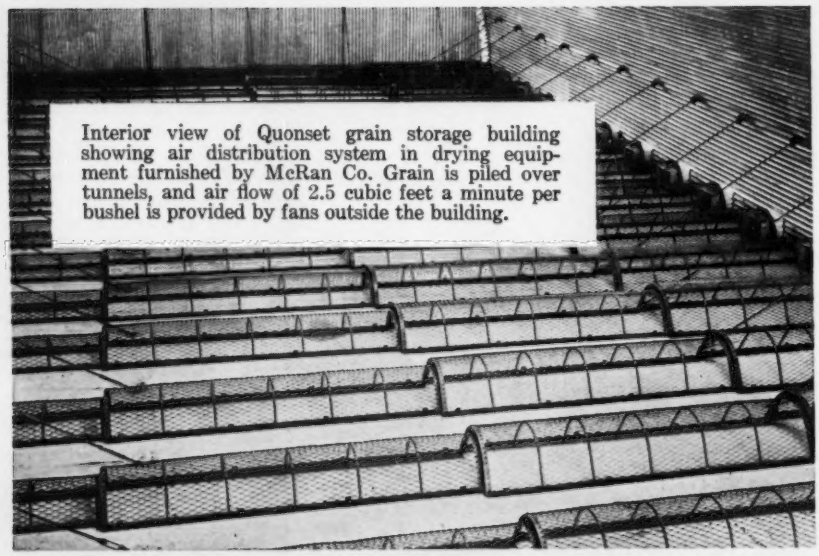
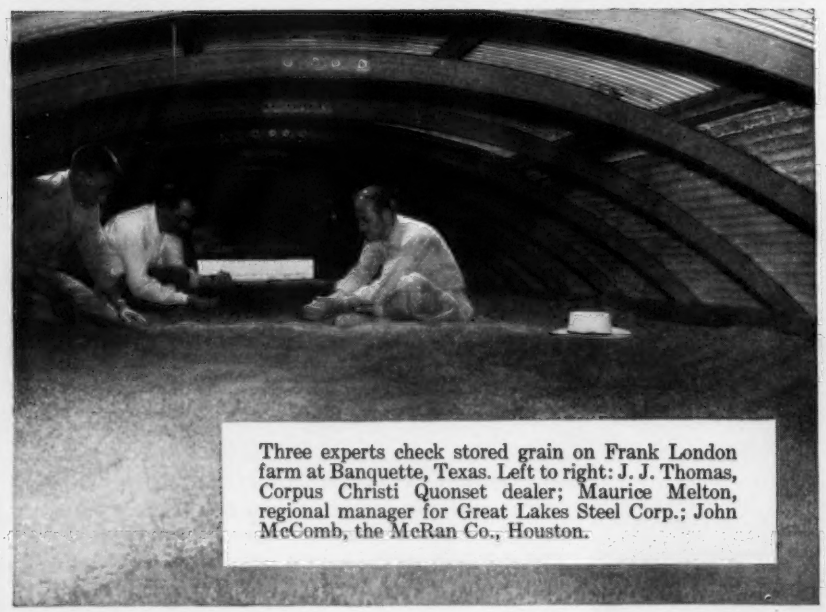


These fans dried 950 tons of Martin milo in the Quonset on Flato Brothers farm near Aqua Dulce, Texas. From left to right, J. J. Thomas, Corpus Christi Quonset dealer; Carl Allen, operator; S. T. Russell, Central Power and Light Company.



Interior view of Quonset grain storage building showing air distribution system in drying equipment furnished by McRan Co. Grain is piled over tunnels, and air flow of 2.5 cubic feet a minute per bushel is provided by fans outside the building.



Three experts check stored grain on Frank London farm at Banquette, Texas. Left to right: J. J. Thomas, Corpus Christi Quonset dealer; Maurice Melton, regional manager for Great Lakes Steel Corp.; John McComb, the McRan Co., Houston.

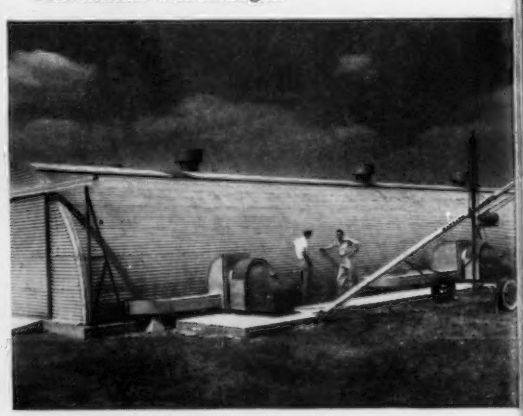
TEXAS—with its usual comments about the biggest and best of everything—might also apply the term of "biggest" to the problem of keeping farm stored grain in condition in the Gulf Coast region. In this area, drying is usually a must, and farmers have taken to the process of drying grain sorghum on the farm with a rush that has amazed the "researchers" and building dealers alike.

Although drying is a successful process with most grains in other sections of the country, it would be hard to find the quantity of a "toughie" like grain sorghum that is being farm-dried in an area of adverse weather conditions, such as found near the Gulf Coast. Until just recently farm storage of grain in this area has been discouraged by moisture and insect problems.

Searching for a solution, extensive tests on drying grain sorghum in different types of buildings have been conducted at Beeville, Texas, under the direction of J. W. Sorenson, Jr., Research Engineer for the Texas A&M College Agricultural Experimental Station.

While contributions to this work

This Quonset 20x84 on Frank London's farm at Banquette, Texas, equipped with a drying system furnished by the McRan Co., was filled with 452,000 pounds of grain sorghum loaded through roof hatches with an auger.



Coastal Plain Dries its Grain

When warm winds sweep off the Gulf of Mexico to blow across Texas and Louisiana, you can practically grab a handful of air and squeeze water out of it. It's a tough area to dry grain in, but grain growers who own Quonset buildings and drying equipment solved their moisture problems.

have come from many sources, considerable support has been furnished by Great Lakes Steel Corporation, and the McRan Company of Houston (South Texas distributors of Quonset buildings).

Experience gained from the past several years of research has pointed up the following principles for successful drying and storage on the farm for this area: (1) Use good, weathertight storage structures; (2) Store clean grain; (3) Dry the grain to 12 per cent moisture content or lower; (4) Use a recommended rate of 2½ cubic feet per minute of unheated air per bushel of grain; (5) Aerate the grain during the storage period; (6) Fumigate for insect control; (7) Check the condition of the grain frequently.

These essentials of drying and storage, along with other technical information concerning design and operation, have been circulated by county agents, the ASC, electric power suppliers, building dealers and others interested in this particular farm operation.

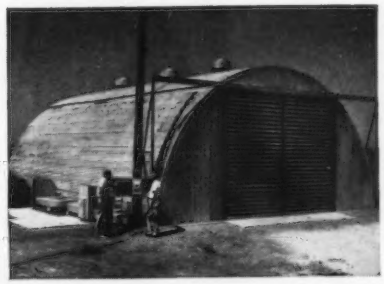
Since the method has passed from the confines of research to an everyday farm operation, the concern of dealers and agricultural leaders has been that nothing be allowed to happen to give the procedure a chance for failure. New types of equipment and unfamiliar methods of operation always pose problems in any industry.

Checks and double checks are being made on new installations to help the farmer be sure that his grain is dried properly and adequately, and that it remains in condition for this storage year.

The Quonset dealer in this area also recognized the responsibility of several million dollars worth of grain on these farms and has a member of his organization call on farm drier operators with advice and assistance to insure that best possible results are obtained with the equipment installed.

Grain drying with unheated air in "on farm" storage structures appears to be permanently adopted as a profitable farm operation. There is no question but that experience and research will continue to give all of us new ideas and better ways of doing the job, just as they have affected all other farming enterprises.

Edwin Schnieder, Mathias, Texas, runs the efficient drying system in his Quonset 32x48 from this master control panel at corner of building. Fans can be moved from one duct opening to another. The power cost for drying grain has been under 2 cents per 100 pounds.



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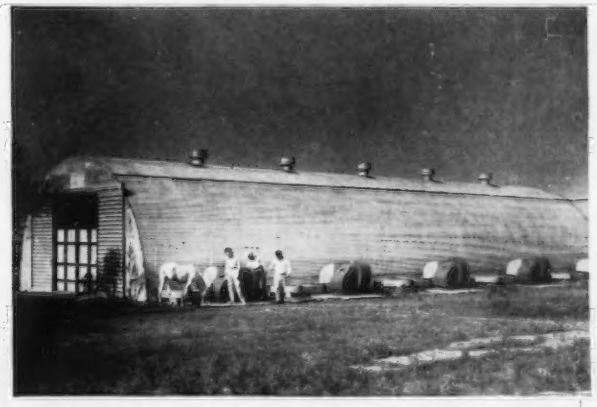
This Quonset on the Harlan Kelly farm, Aqua Dulce, Texas, was built for implement storage. It was converted to a grain drier by installing ducts in the building, with a fan blowing air into them from each end of the building.

This Quonset 32x96 on the farm of J. W. Mayo, Jr., at Taft, Texas, has successfully dried 1,066,000 pounds of grain sorghum to less than 12% moisture for safe storage. Drying used 12,760 kilowatt hours of power, or .072 KWH per bu.



raising snap beans is no snap

PHOTO COURTESY THE JAEGER MACHINE COMPANY, COLUMBUS, OHIO

But Modern Chrysler Power provides Mighty Assistance– Result Here: a 200% Increase in Yield

This healthy stand of snap beans was pictured in New York State in August, 1954. At that time the area was experiencing a particularly dry growing season. Yet, with the aid of supplemental irrigation, this 250-acre farm produced three tons of beans per acre compared with one ton per acre the previous crop. That's a 200% increase.

The farmer's Chrysler-Powered Jaeger 6-CPH Irrigation Pump delivered 54,000 gallons of water per hour, 1,080,000 gallons per day. In twenty-one consecutive 20-hour days *more than twenty-two and a half million gallons* of water were supplied by this combination of efficient pump and Chrysler Ind. 24A V-8 Engine.

By far the greatest number of farmers and growers irrigating use pumps powered by Chrysler, either Short-stroke Low-friction Industrial V-8 Engines or the Power-packed In-Line Sixes. There is good reason for this popularity. Pump manufacturers know that Chrysler Power offers *real* industrial engine features. Features like sodium-cooled exhaust valves, valve rotators, extra wear-resistant stellite valve heads and valve seat inserts, heavy-duty hardened forged steel crankshafts and large tri-metal crankshaft bearings have helped to establish the reputation Chrysler Industrial Engines have for long, *carefree*, economical performance.

Finally, Chrysler Industrial Engines offer a choice of gasoline, butane or natural gas burning carburetors with which to adapt power to the local fuel preference.

Remember, too, that Chrysler Industrial Engines are not expensive. Production-line methods adapted to specialized industrial engine building provide a custom-built engine at mass-production prices. See a Chrysler Industrial Engine Dealer, or write: ***Dept. 175, Industrial Engine Division, Chrysler Corporation, Trenton, Michigan.***

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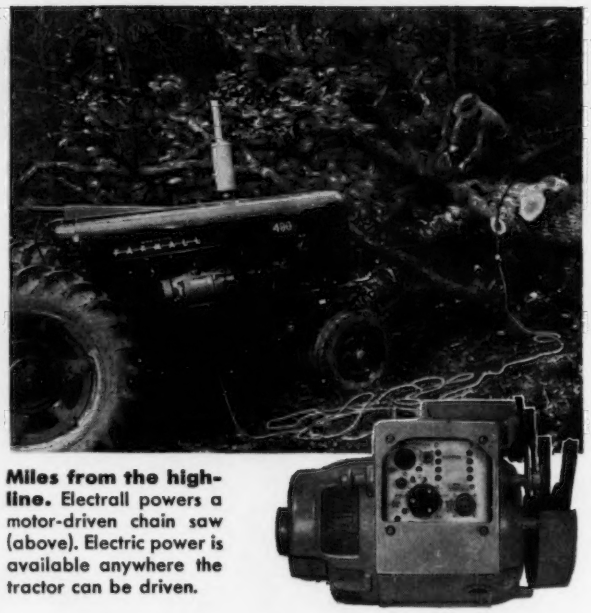
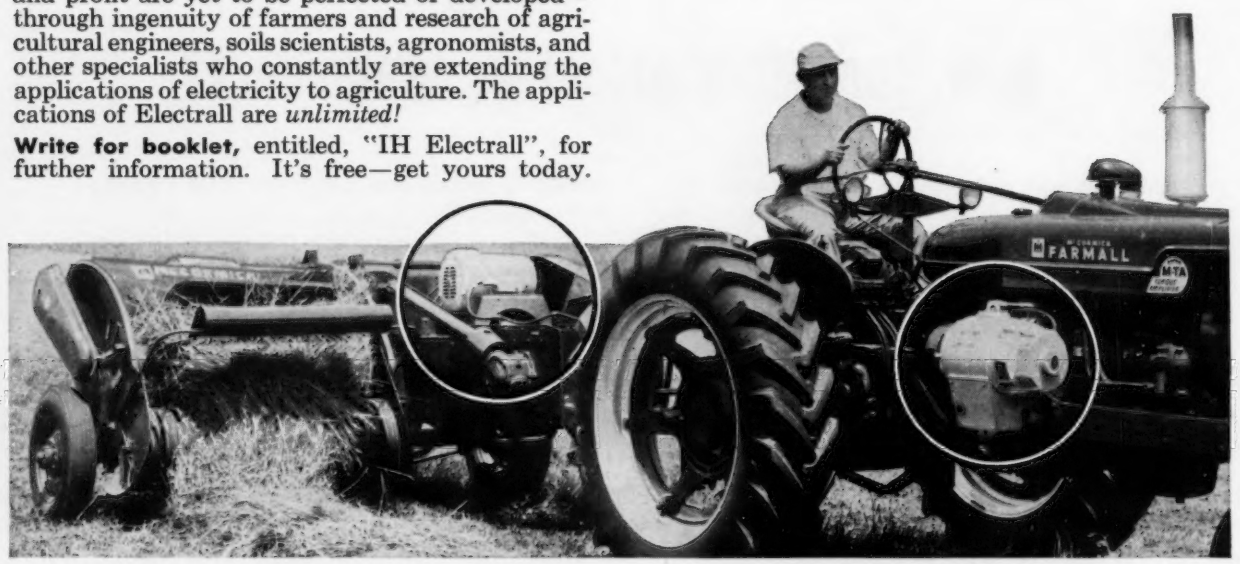


Miles from the high-line. Electrall powers a motor-driven chain saw (above). Electric power is available anywhere the tractor can be driven.

Electrall distribution panel. An outlet is provided for 115-volt 15-ampere, 60-cycle, single-phase power. Another single-phase outlet supplies approximately 6.2 kw for 220/208-volt service. A 10-hp motor can be operated with power from the three-phase outlet. Generator capacity is 12.5 kva.



Electrall generator powers a 10-hp Electrall motor to drive a McCormick No. 55-W hay baler.

IH engineering teamwork produced the application of Electrall to the Farmall and International tractors. IH research, engineering and manufacturing men are constantly pooling time and talent to provide equipment of wider application and improved performance to make the farmer's work easier while boosting production.

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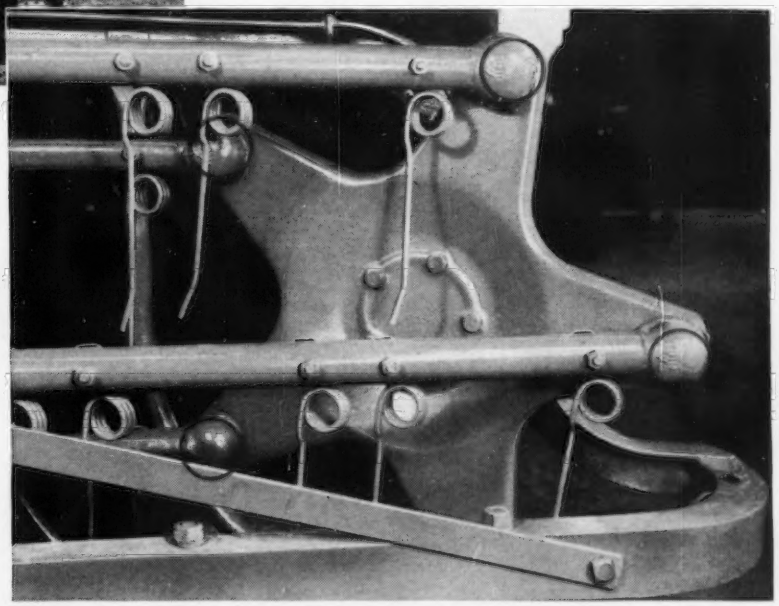
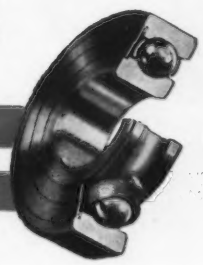


The low cost and design efficiency of BCA *package unit* Hay Rake Bearings have attracted wide attention. These pre-lubricated, triple-sealed ball bearings have been thoroughly proved in severe service—in all kinds of weather, under all soil conditions.

If you have a bearing problem, BCA engineering cooperation and design assistance will provide the positive solution.

Closeup showing how BCA package unit bearings are placed at end of tine bars in five-bar reel on New Holland Model 55 ROLABAR Side-Rake. Ball bearings are grease-packed and sealed for life to keep out trash, mud, and water.



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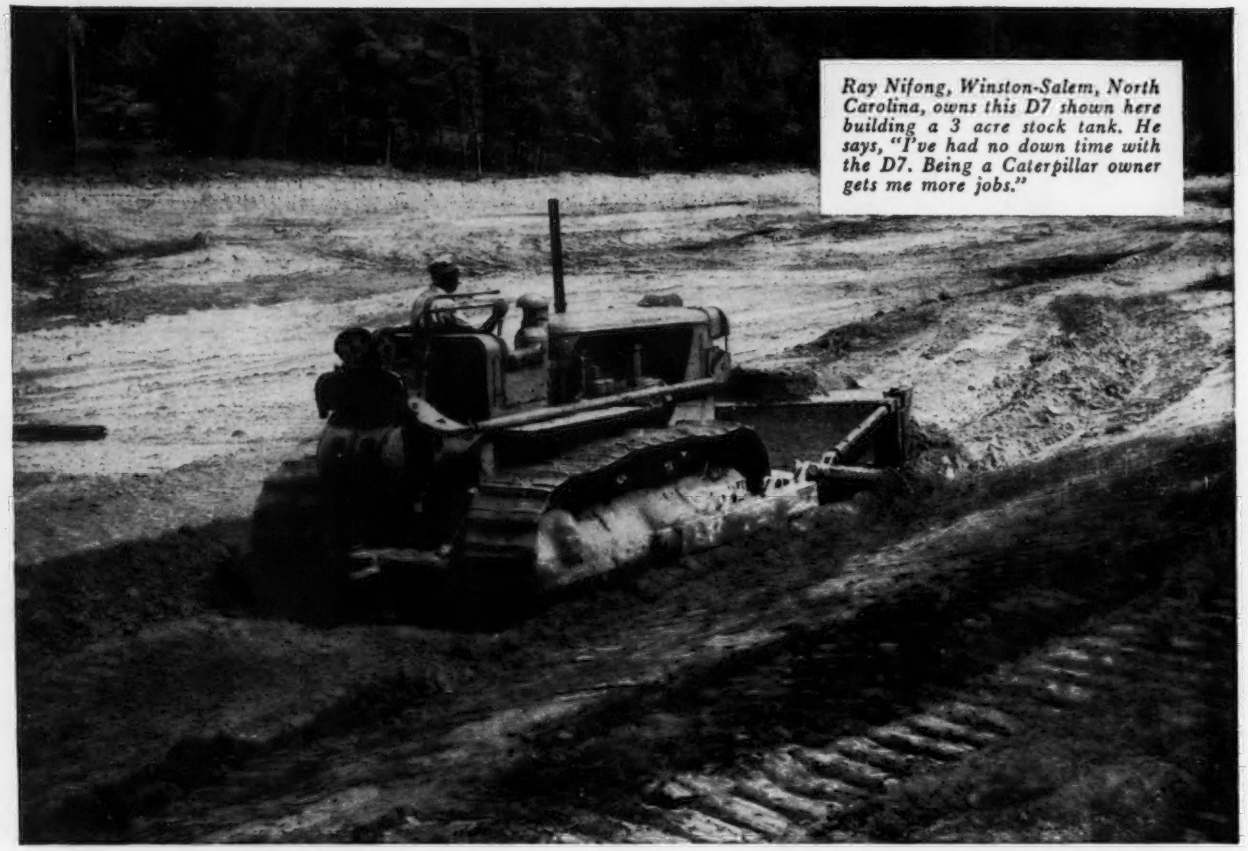

Ray Nifong, Winston-Salem, North Carolina, owns this D7 shown here building a 3 acre stock tank. He says, "I've had no down time with the D7. Being a Caterpillar owner gets me more jobs."

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AGRICULTURAL ENGINEERING

VOL. 36 MAY, 1955 NO. 5

Strain Gages and Stresscoat in Machinery Design

L. H. Schoenleber
Member ASAE

Proved techniques, such as strain gages with the aid of stresscoat and electronic recording instruments and pickups, for measuring a wide variety of phenomena are now available, and their rapidly expanding use in developing farm machinery is proving an exceedingly useful tool to the design engineer

AGRICULTURAL implements and machines are often complicated and are required to function under many varied conditions, which greatly increases the difficulties of engineers who design and develop them. Designing a machine by mathematical analysis alone may involve considerable error as many formulas require assumptions. The design, therefore, has often been by trial-and-error methods, if not by experience and good judgment. There is little information available on the changing forces, velocities, acceleration, pressures, torque, displacement in complicated mechanisms such as corn pickers, combines, balers, etc., operating under varied conditions. There remains considerable mystery about what happens when such machines as tillage tools, forage blowers, etc., are used.

In order to intelligently design a machine, there are many factors which should be known if it is to stand up and function satisfactorily. Whether a machine is functionally sound can be determined only by field testing under all varied conditions under which it will be expected to operate. To determine whether a machine is structurally sound, it is possible to develop it in the laboratory and on processing grounds where the engineers can expect to obtain the answers on proper design more economically and quickly than if the machine were to be operated and developed in the field. Considerable time can be saved between the drawing board and regular production if the use of modern techniques such as strain gages with electronic measuring equipment and stresscoating are used to determine whether the machine is structurally and mechanically sound. These techniques should be used only on a pilot machine or model to determine their design and functional characteristics.

Method of Approach and Analysis of Problem

A definite, concise approach should be followed to determine the proper design and whether the design is structurally sound and adequate. Before any work is done on a machine, the engineer should first outline the specific problem in a clear, concise and definite statement of his objectives. The method of approach to the problem should be analyzed in detail. All factors related to his problem should be carefully evaluated. After the problem has been analyzed, proper facilities should be found to carry out the work. These facilities are necessary if best results are to be obtained. An adequate laboratory and test area or processing ground are normally essential for most types of testing and also help the engineer to obtain more reliable information in the shortest possible time.

The design engineer is confronted mainly with the choice of materials to use and the forces and loads to which these materials will be subjected. Normally there is sufficient information available on physical properties of materials to make a wise selection. However, little may be known as to the loads they may be subjected to in modern farm equipment. Normally one or more different types of load, motion or force must be known before the engineer can produce a balanced design. The different factors to be measured usually include one of the following:

- Structural forces, both tension and compression, for both static and dynamic loads in different component parts of a machine. This might include such forces in structural members of combine braces, axles, wheels, gears, sheet metal, chains, belts, pitmans, etc.
- The frequency and magnitude of torsional loads on propelling shafts of different machines.
- Drawbar loads of different agricultural implements and tractors.
- Rate-of-motion change, acceleration and deceleration of linear, irregular or rotating motion of parts, accessories, or assemblies of farm machines, tractors or engines. This might include engine governor action, engine valve motion, machine travel, frequency and extent of motion of hydraulic cylinders, combine sieve motion, tillage tool and plow depth, etc.
- The frequency and magnitude of vibration for machines and component parts.
- Shock loads in belt or chain drives and on rotating shafts.

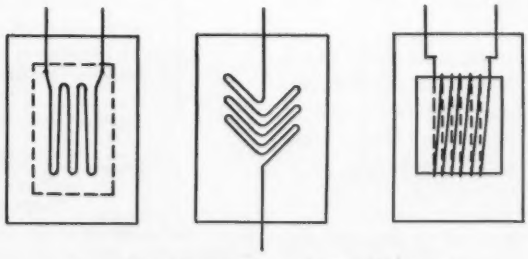

Fig. 1 Typical strain-gage grid configurations

Paper presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1954, on a program arranged by the Power and Machinery Division.

The author—L. H. SCHOENLEBER—is engineer in charge of the central testing laboratory, J. I. Case Co.

- Time cycle for definite operations, such as the knotter cycle on balers, etc.
- Electrical characteristics of engine ignition systems and starter-cable voltage losses.

In many cases the foregoing factors cannot be calculated to any degree of accuracy, but must be measured on a model or experimental machine.

Nearly all the above phenomena can be obtained by use of transducers employing strain gages. In most stress analysis the strain gage is used to determine the strain. It is therefore important that something about strain gage characteristics and their performance be known.

Strain Gage Theory

The principle of the SR-4 gage is extremely simple. This gage consists of a length of several inches of fine (0.001-in-diameter) resistance wire arranged in various patterns and sizes and mounted in an insulating medium, normally two pieces of thin paper, which is cemented firmly with specific adhesives to a specific member or part that is being tested. Changes in surface dimensions of this part, under changing load conditions which may be either tension or compression, are transmitted to the gage, As a result, the wire is deformed to the same extent as the surface of the part being tested. According to Poisson's ratio, when a wire is stretched the length changes while its diameter changes by a factor. The electrical resistance of a wire is affected by its change in length and in diameter. The amount of the change in resistance in relation to the change in length is a measure of the strain sensitivity. This ratio is called strain sensitivity or gage factor, or

$$K = \frac{\triangle R}{R} \div \frac{\triangle L}{L}$$

where K = strain sensitivity factor of the wire

$\triangle R$ and $\triangle L$ = corresponding changes in resistance and length, respectively

R = initial resistance of gage

L = initial length of wire.

According to Hooks law, stress is proportional to strain in elastic bodies. Therefore, if a strain gage is attached to a body, the change of resistance in a strain gage can be expressed as "change in strain."

At present, there are over 152 different types of commercial SR-4 strain gages available. SR-4 strain gages are now available commercially from many different companies. Normally the selection of a proper strain gage can be obtained by recommendations from the manufacturer of gages, if they are given the conditions under which the gages are to be used and the results desired. It is important that the engineer knows something about the factors which affect strain gages.

Some of the more important factors have been shown by W. T. Bean in a paper entitled "Manual on Experimental Stress Analysis Techniques". Most of these factors are of vital interest to the design engineers who use them. Some of these factors will be mentioned in this paper.

Types of SR-4 Strain Gages

SR-4 strain gages are usually classified by filament material and by mounting (or carrier) materials. Although a variety of filament materials are available which exhibit strain-sensitive characteristics, only two are utilized in the construction of SR-4 gages. Type A gages, which are made of advance wire, contain 45 percent nickel and 55 percent copper and have a sensitivity factor of 2.15. Type C gages, which are made of iso-elastic wire, contain 36 percent nickel, 8 percent chromium, 0.5 molybdenum, and the remainder iron and other constituents, and have a sensitivity factor of 3.6. Two general types of mounting materials are used as filament carriers in SR-4 design: (1) paper impregnated with nitro-cellulose cement as in type A and C gages and (2) paper impregnated with Bakelite (phenol resin) cement as in type AB, CB and EB gages. The strain-sensitive wire in strain gages is arranged in a variety of grid configurations to meet specific requirements. Typical grid configurations are shown in Fig. 1 and consist of flat grid, stress grid and wrap-around grid.

Temperature Characteristics

Both the advance and iso-elastic wire have a good linear relationship between unit change in resistance and unit change in strain. The iso-elastic wire is from 50 to 100 times more sensitive to temperature than advance wire. In certain instances the iso-elastic wire may be advantageous as its strain-sensitivity factor is almost twice that of advance wire. The temperature-sensitivity of a filament wire results from the integrated effect of the change in resistance due to the temperature coefficient of resistance of the wire and to temperature-induced strain arising from differences in coefficient of linear expansion between the wire and the test surface to which the gage is bonded.

Temperature characteristics of type A and type C gages are shown in Fig. 2. It is quite obvious from these curves that the advance wire gages should be selected for all applications in which static strain measurements extending over long periods of time are involved. For maximum temperature stability, strain gages should be "temperature compensated" by cementing a dummy gage to the structure and utilizing it in an opposing arm of the Wheatstone bridge circuit which is commonly used for strain gage instrumentation.

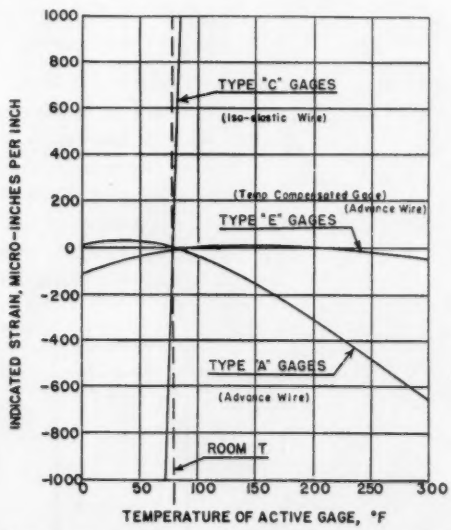

Fig. 2 Temperature sensitivity of SR-4 filaments when mounted on steel. Zero mechanical strain. (Compensating gage at room temperature, 80 F)

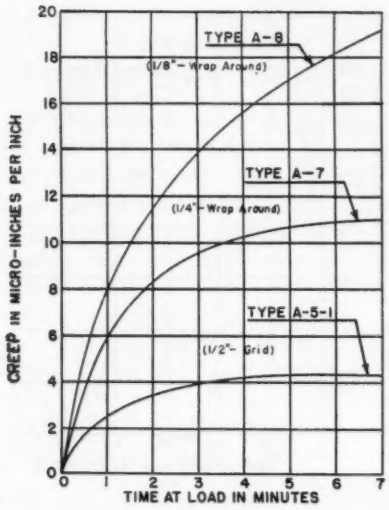

Fig. 3 Creep-time characteristics of SR-4 strain gages. Cemented with Duco household cement. Cured 24 hr at room temperature plus 150 F cycle. Mechanical strain, 2,000 μin per in. Test temperature, 71 F

An alternative is to use a self-compensating gage. For purposes of stress analysis, the dummy gage should be unstrained; of identical gage type, resistance and lot number; mounted on identical material, and maintained at the same operating temperature as the active gage. In this manner changes in resistance due to temperature are identical in the opposing bridge arms, and bridge balance is unaffected.

Creep Characteristics

Creep (or zero shift) can be a perplexing problem to the technician. The inability of the strain gage to retain zero reference of strain and load is attributed to several variables: gage length, gage material, grid configuration, strain level, cement, bonding technique, time, operating temperature, temperature compensation, excitation current, lead wires and environment, and humidity.

Since the filament wire is strained only through the shearing stresses developed in the cement and paper carries, these stresses, for a given strain, must of necessity increase as the length of the grid decreases relative to its height above the surface. It is for this reason that the shearing stresses in the wrap-around gages are higher than those in the flat-grid gage. The room-temperature creep characteristics of several type A strain gages for different time of loads is shown in Fig. 3. The test had been conducted at a tensile strain level of 2,000 μ(microinches) per inch in order to increase shear stresses and the resultant creep. These data indicated that the longer, flat-grid-type gages are more stable than the shorter, wrap-around gages, and the shorter the gage the greater the creep.

Bakelite gages, cemented with phenolic resin, appear to be more stable than paper gages. Fig. 4 will show some characteristics of gages with different mounting materials at different operating temperatures. Maximum operating temperature (±5 per cent) for reliable strain data is 175 F for type A gages, and 350 F for type AB gages.

Gage Length

Strain gages range in length from 1/16 to 6 in. The selection of the proper length of strain gage is very important. The effective length of a gage corresponds to the length of its grid, and the grid can indicate only the "average" strain over its entire length. In order to obtain more significant strain values in areas of high stress concentration, the gage length should be compatible with the strain gradient. This can be illustrated in Fig. 5 which shows the strain gradient in the ¼-in fillet of a cantilever beam in bending. A ¼-in gage would be equal to the radius and is the maximum length gage that should be used. It would be desirable to use a ⅛-in gage which is one-half of the radius. If longer gages were used in the fillet, appreciable error would result when indicating maximum strain. It is also important that the strain gage is properly aligned with respect to maximum principal strains. Proper gage orientation can be determined by the application and use of stresscoat techniques.

Gage Output

The electrical output of a strain gage should be known; it is a function of its gage factor, temperature, excitation, voltage, strain level and electrical circuit.

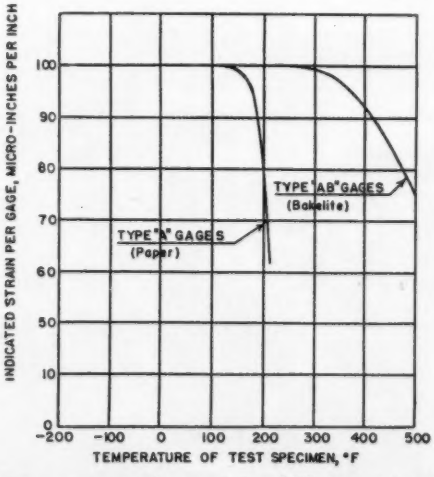

Fig. 4 Temperature-creep characteristics of SR-4 mounting materials. Mechanical strain, μin per in. Creep time, 30 sec. Two active gages in bending, temperature compensated. Type A gages cemented Type B gages cemented with phenolic resin

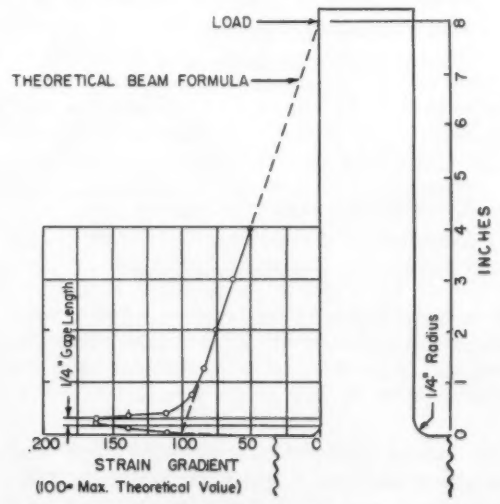

Fig. 5 Strain gradient in ¼-in fillet of cantilever beam. (Rectangular cross section)

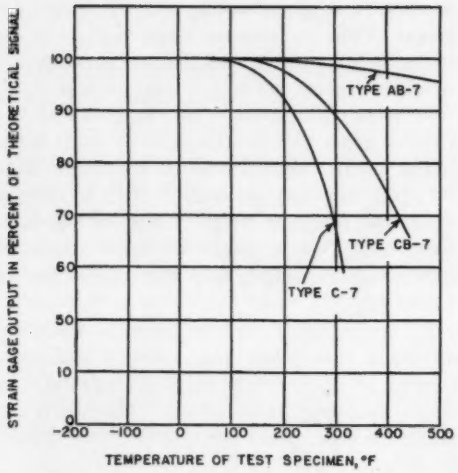

Fig. 6 Temperature-output characteristics of SR-4 strain gages, when cemented with phenolic resin (BC-6035). Dynamic strain = 500 μin per in. Frequency = 25 cps. Gage current = 50 ma

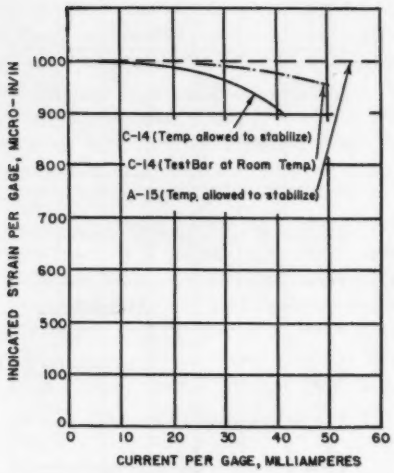

Fig. 7 Current-output characteristics of SR-4 strain gages, cemented with Duco household cement. Mechanical strain, 1,000 μin per in. Four active gages in bending. (Stresscoat calibrating fixture.) Test bar weight, 6 oz. Test bar temperature (maximum), 135 F. Room temperature, 68 F

Temperature-output characteristics of certain strain gages are shown in Fig. 6. Strain gages, types C and CB, can be used for the measurement of dynamic strains of low level providing the instrumentation will not respond to steady-state signals. Thereby, the temperature-sensitivity of the iso-elastic wire is eliminated and a greater dynamic signal is obtained. A reduction of dynamic signal as shown for C and CB gages is not due to creep, but results from a reduction in gage factor with respect to temperature.

Type-C gage should not be used for temperatures above 175 F, and type CB gages above 250 F. Type AB gages should not be used for temperatures above 500 F. Instrumentation involved in such dynamic tests usually does not exceed an accuracy of ± 5 percent.

When strain gages are arranged in a Wheatstone-bridge circuit with all four arms active, the bridge output can be expressed as

$$E = KVN \text{ (in terms of voltage)}$$

where E = output of bridge, microvolts

K = gage factor

V = excitation to bridge, volts

N = unit strain, microinches per inch.

In terms of current

$$I_b = \frac{E_b}{R + R_g} \quad \text{or} \quad \frac{KVN}{R + R_g}$$

where I_b = output of bridge, microamperes

R = resistance of gage, ohms

R_g = resistance of galvanometer, ohms.

It is apparent that bridge output is proportional to excitation voltage. The maximum excitation voltage that can be used will be governed by the ability of the gage filament wire to dissipate its heat to the structure to which it is attached.

The current-output characteristics for high resistance gages type A and type C are shown in Fig. 7. This chart indicates that a type A-15 gage carrying 60 ma (milliamperes) of current will not experience a reduction in gage factor. The type C-14 gage is reduced 9 percent at a current of 40 ma. Part of this loss was due to the increase in test-bar temperature. When the test bar was kept at room temperature, the reduction was less, or about 3 percent. Iso-elastic wire is not as stable as the advance wire with regard to temperature and current.

Endurance

Normally SR-4 strain gages will have a lower endurance life than the material to which they are cemented. Very little data are available which shows the fatigue resistance for SR-4 strain gages. Certain types of strain gages have been designed to possess better fatigue qualities. These gages have been constructed by using a "dual-lead" or intermediate size wire between the grid and regular lead wire.

Application of Strain Gages

The technique of installing strain gages can be gained only by experience. There are many precautions that should be observed when installing gages that cannot be covered

Fig. 8 Stresscoat strain analyzer

in this paper for the lack of time. However, some of the more important factors will be mentioned.

Surface preparation to which the gage is to be bonded should be thoroughly and properly cleaned. All dirt, scale, paint and grease must be removed. Proper cements should be applied for the different gages according to instructions and recommendations of the manufacturer. The curing time and conditions are very important if best results are to be obtained. Adequate shielding of lead wires is necessary and protective coatings over the gages will help to preserve the gages for longer service.

At first the engineer might be perplexed to know what gages should be selected for his use. In general, a strain gage should be selected according to its ability to meet the test conditions. The order of importance of strain-gage properties on which they might be selected are as follows:

- Gage factor, the higher the better.
- Resistance, the higher the better. Electrical resistance should be high since electrical output of a gage is proportional to gage resistance for a given excitation current.
- Temperature coefficient of resistance. The lower the better so the gage will not be too temperature sensitive.
- Coefficient of linear expansion, the lower the better.
- Melting point, the higher the better.
- Thermoelectric behavior, or the tendency to generate a thermal emf at the connections, the lower the better.
- Physical properties, hard and springy or soft and easy to solder. Also does the wire show a hysteresis loop in a cycle of stress?
- Fatigue resistance—the life or endurance to be as great as possible.

Stresscoat

In many cases it will not be known where a strain gage should be bonded to the test specimen in order to measure maximum strain. Another tool is available which has been found to be useful and necessary for stress analysis. This tool is called stresscoat and is the trade name for a series of brittle lacquers which are used for

- Locating small areas of high stress and direction of stress on surfaces of loaded parts
- Measuring tension and compression stress concentrations under static loads
- Measuring tension stress concentration under impact loads
- Measuring tension and compression residual stresses
- Measuring locked-up assembly stresses
- Indicating localized plastic yielding
- Fatigue problems

Stresscoat has a number of advantageous characteristics. Its effective gage length approaches zero; it shows an overall picture of the strain distribution and high-lights areas of stress concentration; it is applicable to any mechanical part or structure, regardless of material, shape or manner of loading, and it gives principal strain and stress directions at every point on the surface of the object.

Stresscoat cracks at right angles to the direction of the maximum tensile strain which will indicate the exact location and direction of axis where a strain gage should be located. Lacquers are available to crack at strains from 100 to 1500 μin per in. The brittleness of the lacquers is quite sensitive to temperature and humidity. If a lacquer is strained at a temperature above that for which its use is normally prescribed, a greater strain will be required to produce cracks, and if at a lower temperature, a lesser strain. Extremely low temperatures will cause the lacquer to crack all over in a random manner without the presence of strain. Humidity variations have similar effects in that the sensitivity of the lacquer to strain is decreased with high humidity and increased with low humidity. Recently developed stresscoat all-temperature ceramic coatings are insensitive to temperatures up to 700 F and are available for use on steel. Normally best results can be obtained at room temperature.

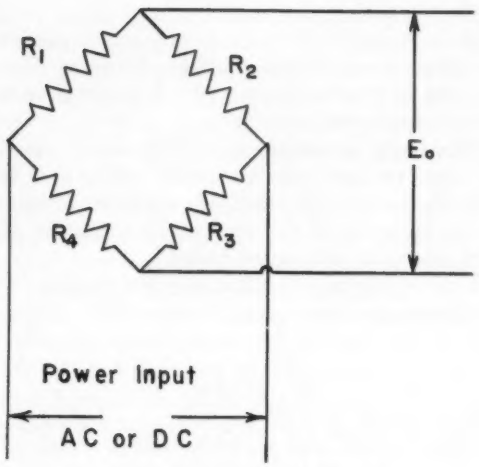

Fig. 9 Wheatstone-bridge circuit

Considerable care must be exercised when stresscoat is used for stress analysis. The accuracy ranges from 5 to 25 percent, depending upon the skill of the operator. It is exceedingly important that the test specimen is thoroughly cleaned of all paint, rust and grease, and then an aluminum undercoating sprayed on and dried before applying the lacquer. The lacquer should be sprayed on evenly and allowed to dry for the prescribed time under proper conditions. At the time the test specimen is prepared, a number of cantilever calibration strips should be sprayed which are used to determine the actual threshold cracking strain for the particular temperature, humidity, and loading conditions coincident with that test.

The type of equipment used for applying stresscoat is shown in Fig. 8. This is called a stresscoat strain analyzer (ST103A) and is made by the Magnaflux Corporation.

Computing Stress From Strain

After the threshold cracking strain for stresscoat on a specimen has been determined, the apparent stress is computed by multiplying strain by the simple tension modulus of elasticity of the material of the test specimen, regardless of the type of loading.

$$S = E \times \varepsilon$$

where S = stress in pounds per square inch
E = modulus of elasticity of material under test in pounds per square inch
ε = strain in inches per inch.

Instrumentation

The strain gage is a very necessary and important item when determining maximum stress. However, the SR-4 strain gage by itself is of no value. It is the sensitive element in a strain measuring system.

When single or multiple gages or transducers employing strain gages are used, they are usually placed in a Wheatstone-bridge circuit. The changing resistance of the strain gage due to strain of the material, to which the gage is bonded, causes an unbalanced bridge.

There are many ramifications of different circuits that are used to measure strain-gage resistance and is governed mainly by the type of instrumentation employed. Most bridge circuits basically are similar to Fig. 9 or modifications of this circuit. The four arms of the bridge are strain gages R_1, R_2, R_3 and R_4. In some instances, four strain gages may not be used. In this event, the bridge may be completed with precision wire-wound resistors. The bridge may be set up so that the only source of unbalance is change of resistance in one gage. This arrangement is not the most desirable as SR-4 gages are sensitive to temperature as well as strain as previously pointed out. The effect of temperature can be eliminated by placing a dummy gage in one of the other arms of the bridge. R_1 could be used as the active gage bonded to the stressed material. The dummy gage, R_4, is bonded on unstressed material and the two gages are located in the same region so that they are subjected to substantially the same temperatures. R_2 and R_3 are resistors used to complete the bridge.

The final bridge circuit will vary depending on instruments that are used to measure the unbalanced bridge. The a-c Wheatstone-bridge circuit used with Brush BL-320 universal amplifier and BL-222 double-channel oscillograph is shown in Fig. 10. Brush equipment was used for nearly all field dynamic measurements that we have made. R_n, R_p, R_a and R_b are active elements of the bridge and can form either one, two, three or four arms of the bridge.

The calibration resistor connected across one arm of the bridge (bridge terminals 1 and 3) is used during calibration of the instrument. The resistance of the gages and number of active arms of the bridge determine the microinches per inch of strain for calibrated pen displacement. If one 120-ohm gage is active in the bridge, then one line deflection on the chart is equivalent to 10 μin per in of strain. If two arms of the bridge are active, one line deflection on the chart is equivalent to 5 μin per in of strain; when all four gages are active, one line deflection on the chart is equivalent to 2.5 μin per in strain. This is based on the assumption that a 390,000-ohm calibration resistor is used.

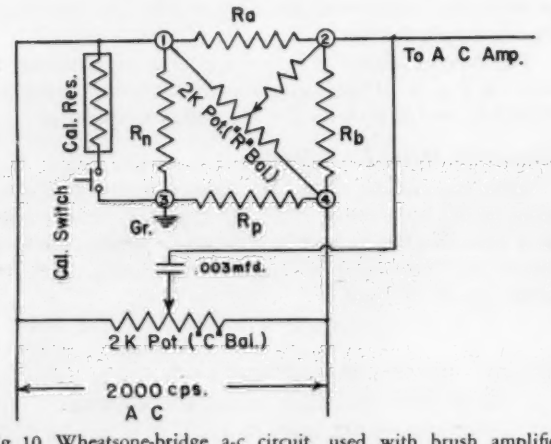

Fig. 10 Wheatsone-bridge a-c circuit, used with brush amplifier and oscillograph

Whenever possible it is desirable to apply a known load to the member to which the gages are bonded and note the deflection on the chart. In this way, the chart can be calibrated to read inch-pounds of stress per line. Fig. 11 illustrates how a known torque load is applied to a shaft for calibration purposes. Extreme care should be exercised when calibrating a shaft or other components.

Basically all instruments perform the same function or they indicate or record the amount of output from the electrical circuits containing the strain gages. When an electrical current is passed through a bridge, and changes in resistance of the strain gages varies with the applied strain, this change in resistance is measured with appropriate instruments. The measuring instrument may be a simple potentiometer or a good Wheatstone bridge with a sensitive galvanometer such as the Wheatstone-bridge recorder; or it may be an electronic strain indicator, graphic recorder or a recording oscillograph.

The selection of measuring equipment will be governed mainly by the measurements which are to be taken and conditions encountered during measurement. Different equipment might be required when measuring either static or dynamic loads if best results are to be obtained. Each type of equipment will have its advantages and its limitations. The engineer, therefore, must know under what conditions the equipment will be working. Some of the factors governing the selection of equipment are as follows:

- Visual or recording type required
- Frequency response and magnitude of loads
- Ruggedness, response to transportation shock and vibration
- Simplicity of operation
- Accuracy
- Number of channels for obtaining different phenomena.

Certain measuring equipment has proved very satisfactory in our work. It includes the Baldwin SR-4 indicator, which is used mainly for static load tests; however, this type of equipment is available now for indicating dynamic loads. This indicator is limited to reading only one phenomena at

Fig. 11 Torque-load calibration of a combine shaft

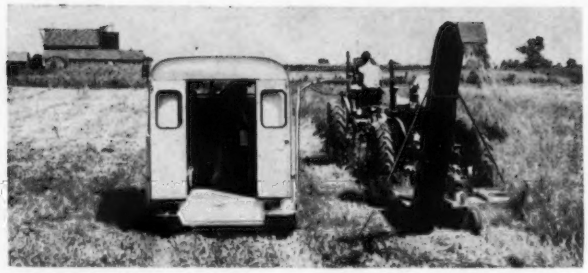

Fig. 12 Measuring torque loads on a utility harvester

a time. The accuracy of this equipment is very favorable, or about 0.25 percent.

The cathode-ray oscillograph, model 304 H with a Westinghouse recorder, has been used to obtain different phenomena having high frequency. This recorder has a film speed of 1 to 5 in per sec and is equipped with a 200-ft roll of 5-in sensitized paper. Following are some of the advantages for using a cathode-ray oscillograph:

- Frequency range and writing speed are enormous
- There is no distortion due to inertia, and dampening is avoided
- Overreading does not cause overstrain or burning
- Convenient for visual determination
- Versatile and easy to operate and adjust
- Compact, portable and quite rugged.

When more than one strain or other phenomena is to be obtained at a time, dual or multiple-channel equipment must be used. We have found that the Brush Development Company's double-channel oscillographs with universal amplifier are very versatile to obtain different phenomena. The magnetic penmotors with proper amplifier will respond to frequencies up to 100 cps. However, frequencies of 80 cps or less will give more accurate results. Both direct-ink recording or electric-stylus recording are used. When inking pens are used, a uniform trace results regardless of velocity of the pen tip. It is not desirable to use inking pens at temperatures below freezing. The electrical styli require that electrosensitive paper be used, which is suitable to use for any ambient air temperatures. The darkening effect of the stylus on the paper is dependent on the velocity (or frequency) at which the stylus is being driven and the chart or paper speed. Chart paper speeds can be 5, 25 or 125 mm per sec.

Some advantages for using this type of equipment have been found to be:

- Convenience of visual observation of the record at the time of test. Results can be determined at the time of testing. Additional tests could be made on the spot to verify previous tests.
- Frequency range of 0 to 80 cps is adequate, for most measurements required on farm machinery
- The equipment is versatile and easy to operate
- The equipment is portable and rugged
- Accuracy of this equipment is very good.

The versatility of strain-gage equipment is unlimited and its usefulness will depend upon the ingenuity and skill of the technician.

When measurements of different types of phenomena are made, special pickups may be needed. In many cases the type of pickup required are not available commercially or the cost may be prohibitive. It would therefore be necessary to implement and devise various ways to obtain the phenomena desired.

One of the most common phenomenon measured on farm equipment are variable-torque loads. Fig. 12 shows a general field view of a utility harvester where torque loads are being measured. The truck shown contains the electronic measuring equipment, and is driven alongside the machine being tested. A typical record obtained is shown in Fig. 13, which shows three different tests that were made. The base line on each chart and the height of the record recorded by the pen will be noted. From the area under this graph and the length of chart taken over a test area, the average torque can be determined. By knowing the speed of the power-take-off shaft, the average horsepower can be determined. Marks at the top of the chart are made by an event marker. The event marker is used to record speed and also show when the test was started and stopped.

When spot torque readings are required, a torquemeter can prove useful and labor saving. Fig. 14 shows four

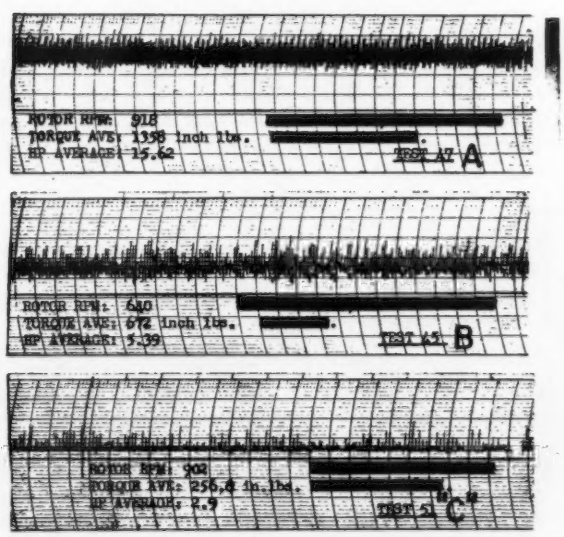

Fig. 13 Typical record of torque measurements made with a Brush recording oscillograph

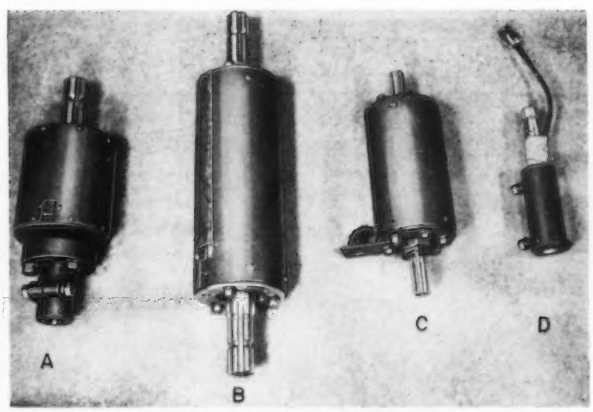

Fig. 14 Four torque meters of different load capacities

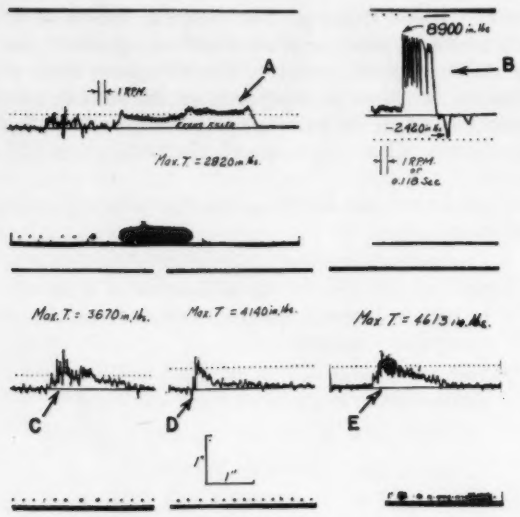

Fig. 15 Measurements of variable torque and shock loads

torquemeters which were made up and have different load capacities. Torquemeters A, B, and C have a rotating shaft and collector rings. The shaft is made of AISI, 8740 steel and hardened to Brinell 320. Capacities are 6000, 4000 and 2300 in-lb, or at standard power-take-off speed, 50, 35, and 20 hp for torquemeters A, B, and C, respectively.

Torquemeter D is used on special applications to obtain steering effort on tractors. The unit is placed between the steering post and steering wheel. This unit has a capacity of 1500 in-lb.

When extended tests of rotating shafts are necessary and it is impossible to install a torquemeter, it would then be necessary to bond strain gages onto the shafts which are to be tested. Four strain gages are bonded to the shaft, two each on two opposite sides of the shaft, so that they are 45-deg helices on the shaft surface. Symmetry must be arranged between the gages relative to the shaft axis and a plane perpendicular to the axis. When the gages are properly mounted, the bridge is insensitive to bending and axial thrust, only strains due to torque are recorded.

Signals from the strain gages must be transmitted from the rotating shaft and bridge through slip rings to the recording equipment. It is essential that variable-contact resistance between the brush and ring be kept to a minimum. Two different types of collectors were used successfully. Silver-graphite brushes working on coin-silver slip rings were used on one type of collector, while copper disks rotating in a mercury pool were used in other collectors. These collectors have less rotating resistance and no contact resistance.

Torque measurements of shafts were made with strain gages bonded to each shaft and collector rings attached to the shafts. Fig. 15 shows a typical record of variable torque and shock loads. Charts A, C, D and E are torque measurements for certain shafts during slug loads in the combine. Chart B illustrates a slug load which stopped the cylinder. The cathoderay oscillograph was used to record peak loads. Frequency response to bridge signals were considered a rate which required this type of equipment in order to obtain a true picture of torque.

When tension or compression loads are required, pickups shown in Fig. 16 (B to G inclusive) can be used. The capacities of each pickup are: B, 250 lb; C, 1500 lb; D, 5000 lb; E, 15,000 lb, and F and G, 7500 lb. The material used in the oval-ring-type unit was SAE 1045 steel hardened to 525 Brinell. A unique example where a pickup of this type was used to determine the loads required to make a plow breakaway function. The plow breakaway is made to function by pull on the hydraulic ram, A record of the loads is shown in Fig. 17. The time cycle for this event is shown to

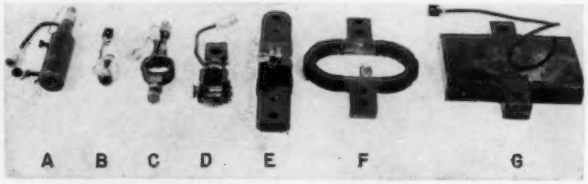

Fig. 16 Pickups for tension and compression dynamometer loads

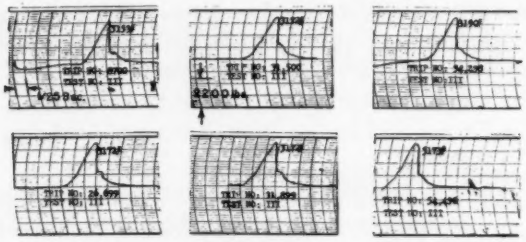

Fig. 17 Record of plow breakaway forces measured with tension dynamometer

be about ⅛ sec. Time and load calibration are shown on the chart.

Another type of pickup built up to obtain information for determining velocity of twine drawn from a baler twine box proved very satisfactory. The magnetic pickup consists of a coil of wire wound on a steel core and mounted on a permanent magnet. When each of the four steel pins, which are mounted on a wooden spool, rotate past the coil it disturbs the magnetic flux passing through the core for a short interval to generate a voltage pulse; thus a signal is recorded. Twine is threaded between two spools which drive the pins past the coil. The pickup was constructed so that one inch of twine is needed to rotate one of the pins past the coil. By recording time and amount of twine used the velocity can be obtained. Records obtained using this pickup are shown in Fig. 18. These events were recorded using the cathode-ray oscillograph and a Westinghouse recorder with sensitized paper. Total time for the two tests required 0.821 sec and 0.833 sec.

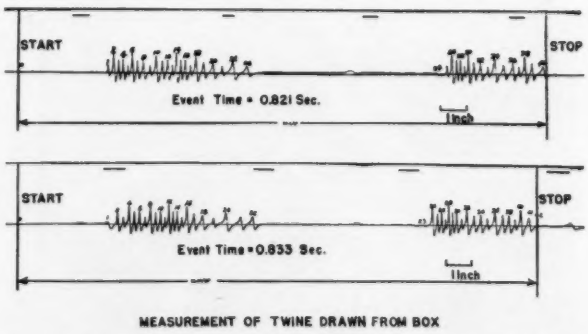

Fig. 18 Record showing amount of twine and time required to draw twine from baler twine box

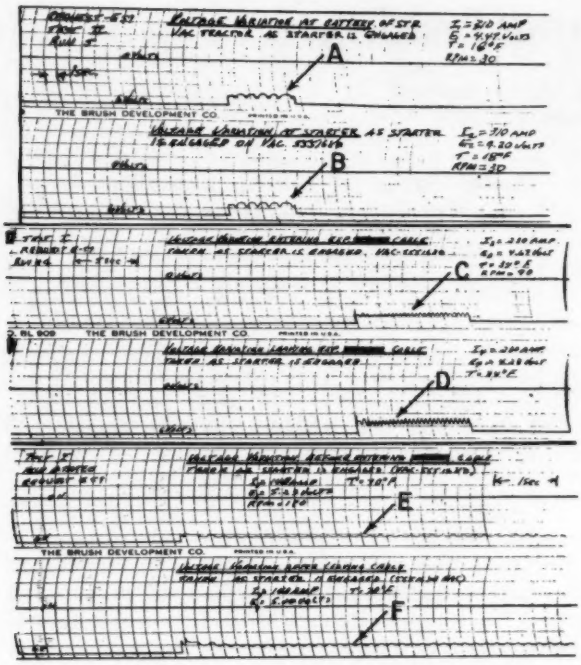

Fig. 19 Record showing voltage drop and variation for different starting cables

An interesting application, where electronic equipment was used to determine the efficiency of a 15-ft auxiliary starting hookup cable, was in using the starting cable to connect the starting motor on a combine auxiliary engine and the tractor battery. The cables were subjected to different ambient air temperatures and the voltage drop and power loss determined. Direct-current voltage at both ends of the test cable were fed into a d-c amplifier and recorded on a Brush recorder. Voltage variation during these tests are shown in Fig. 19. Line A represents 4.47 v entering the cable, and line B, 4.20 v at the end of the cable. On another test, line C represents 4.67 v entering cable, and line D, 4.23 v at the end of the cable. On the last test, line E represents 5.23 v entering the cable, and line F 5.00 v at the end of the cable. Lines E and F were taken with a chart speed of 25 mm per sec.

In many cases the exact location and direction of maximum stress in a machine member are not known. These phenomena can be determined first by stresscoating and loading the member to obtain a stress pattern. When the

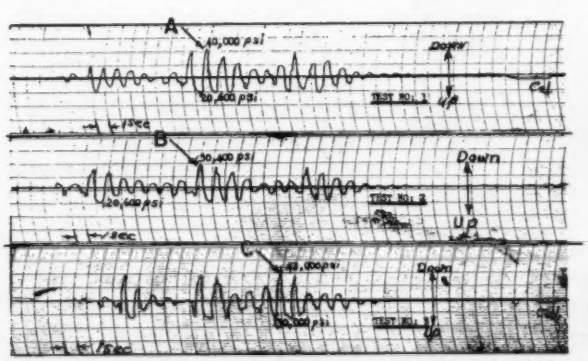

Fig. 21 Record showing dynamic strain loads on cutter bar

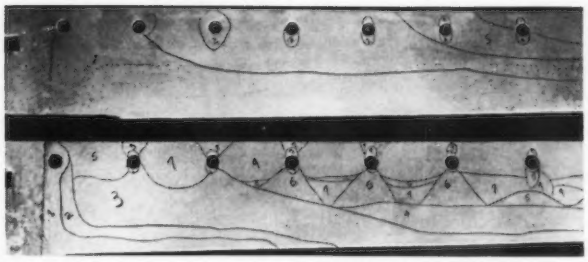

Fig. 20 Mower cutter bar that was stresscoated, showing zones of equal stress

point of maximum stress is located, a strain gage can be bonded to the material at that location. Fig. 20 shows the inner portion of two different cutter bars that were stresscoated. Lines are shown as the boundary of each stress pattern zone. Each bounded area represents 0.0004 in per in strain for certain loads. Area 1 shows a stress-pattern area where 0.0004 in per in stress occurred first for a given load. This area was the highest stressed area for the entire cutter bar. It showed the exact location where maximum stress occurred and where a strain gage must be bonded to measure maximum dynamic loads.

Maximum cutter-bar dynamic stresses were measured operating the mower on a prepared torture track. Measurements taken are shown in Fig. 21. The maximum dynamic stresses found were 43,000 psi.

Another example where both stresscoat and strain gages were used to measure maximum stresses were on the axle of a corn harvester. Fig. 22 shows the axle that had been stresscoated and the pattern area having equal stress located. A strain gage was bonded to the axle at the point of maximum stress. The machine was subjected to severe dynamic loads on a torture track and measurements of axle dynamic load were measured.

Means to obtain some of the most frequent type of phenomena measurements required by the design engineer have been illustrated in this paper. This included measurement of tension and compression loads, shock and varying torque loads, drawbar loads, time cycle and electrical characteristics of starter cables. There are electrical pickups available which can be used to measure other phenomena such as linear and angular acceleration, low and high pressures, differential pressures, linear motion, motion change and engine pressure. Another very useful instrument available is a hand-held gage useful for reconnaissance work to locate optimum areas for more detailed strain studies. This gage has the advantage of repetitive use and speed of application.

(Continued on page 323)

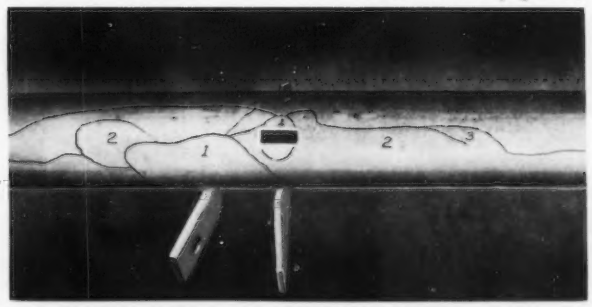

Fig. 22 Corn harvester axle showing stresscoat boundary stress areas and location when strain gage was bonded

Reducing Wind Erosion

Stephen J. Mech
Member ASAE

Better timing of cultural operations is shown to reduce wind erosion of sandy soil under both sprinkler and surface irrigation methods in the Pacific Northwest

DEVELOPMENT of a cloddy soil surface by better timing of the ordinary cultivating operations is a promising means of reducing wind erosion. Tilling sandy soil at a time when its moisture content is high presses many of the single-grain soil particles into small clods or crumbs large enough to resist movement by the wind. These are some of the findings made in a study of the development of an irrigated farm under serious wind erosion conditions in the Columbia Basin Irrigation Project.

This study was set up to provide a field-scale demonstration of the practical development of an irrigation farm under serious wind-erosion conditions, especially those encountered during the early years of development. The farm, located near Eltopia, Wash., consists of about 100 acres of which 83 acres are classed as irrigable. It has a total of 59 acres of class 2 land and 24 acres of class 3. The class 2 land is Othello fine sandy loam; the class 3 is Quincy loamy sand and Burke loamy sand.

The operation of this farm is planned and directed by representatives of the Washington Agricultural Experiment Stations, the U.S. Bureau of Reclamation, and the Soil Conservation Service and the Agricultural Research Service of the U.S. Department of Agriculture.

The farm is being developed in three stages. Half of the farm was developed in the spring of 1954 and an additional one-fourth of the total acreage was leveled in the summer of the same year. The remainder will probably be developed in the summer of 1955.

Both sprinkler and surface irrigation methods are being used. Irrigation, tillage, selection of crops, crops residues, chemicals and other practices in the control of wind erosion are being demonstrated.

Conclusions reached from this study are summarized in the following paragraphs.

Timeliness of operations is the essence of successful farming, especially in the wind erosion area. Tilling the soil when it has a high moisture content will develop "clods" or "crumbs." Conversely, once the desirable cloddy surface is established, tillage performed when the soil moisture is low will tend to break down the clods. Tires and rollers, particularly, tend to pulverize the soil and increase the erosion hazard. In general, tillage operations should be reduced to the minimum.

Tillage of these sandy soils when they are wet does not appear to have any adverse effect on soil structure. The clods are fragile and very little force is required to break them down.

The soil clods or crumbs "slake down" when exposed to water. Water in an irrigation furrow will "melt" the soil within its reach. Under sprinkler irrigation, the impact of falling water tends to break down the clods to single-grain particles.

It is impractical to irrigate often enough to prevent soil blowing. Wind erosion is primarily a surface phenomenon. When the surface dries out to a depth of two soil particles, the top one will "blow." The depth of drying may be only a minute fraction of an inch and the soil below this dry surface may be wet, but, if the surface is dry and the wind blows, it will erode unless the soil particles are consolidated into clods or protected by vegetation.

Ridging to prevent erosion is most effective if it is done at a moisture content that will produce clods. In fact, ridging when the soil is at a low moisture content may actually increase the erosion hazard because it loosens the soil and tends to break down any clods that may be present.

Straw and similar crop residues when disked on the surface offer good protection from wind erosion. They are recommended for spot control. On the other hand, the volunteer growth usually accompanying their use can be very objectionable in low-growing row crops. A surface application of wheat straw to a bean field gave excellent protection against wind erosion, but the crop was almost a complete loss because volunteer wheat growth in the rows not only retarded the beans but made harvesting with a combine impossible.

At no time should more land be developed for irrigation than can be handled properly by the operator. The multitude of problems and unanticipated delays common to the development of new land throw an additional burden on the farmer and often preclude timeliness of operations. Delayed planting and overextension of farming operations have often resulted in complete loss of crops.

Leveling during the summer is highly recommended. Summer is not only the season of lowest wind velocities, but it allows more time for establishment of the irrigation system and seeding of cover crops. Spring, on the other hand, is the period of greatest erosion hazard: the wind velocities are highest and vegetative protection is at its lowest. By doing part of the leveling during the preceding summer or fall, or delaying a portion of it until the following summer, the spring work load will be diminished. Planting and cultivation can be done at the desirable time thereby improving yield prospects.

Summary of a paper presented at a meeting of the Pacific Northwest Section of the American Society of Agricultural Engineers at Spokane, Wash., October, 1954.

The author—STEPHEN J. MECH—is irrigation engineer, Soil and Water Conservation Research Branch (ARS), U.S. Department of Agriculture (Prosser, Wash.), and Washington Agricultural Experiment Stations cooperating.

Evaluating Dusting and Spraying Efficiency

R. W. Brittain, R. D. Brazee and W. M. Carleton
Assoc. Member ASAE Assoc. Member ASAE Member ASAE

Titrimetric analysis shows promise as fast, simple, inexpensive way to evaluate deposits of copper-containing pesticides on plant leaves

SINCE 1950 the agricultural engineering department of Michigan State College has had a research project devoted to finding ways of improving the efficiency of insecticide and fungicide application. One of the problems involved in this project was the quantitative evaluation of insecticidal deposits on plant leaves. Most methods used for this purpose have involved chemical analysis of the leaf deposits, and were time consuming and costly. Frequently the results were not known until several months after the samples had been taken. Other evaluation methods such as leaf-printing techniques were also time consuming. Therefore, it was felt that these slow methods were impractical and a more rapid method was sought.

A method for evaluating deposits of pesticides containing copper, which involved extracting the pesticide from treated plants with a suitable extractant and titrating the copper in the extracts with sodium thiosulphate solution, appeared to show promise; hence it was investigated. This is a well-known method for determining the copper content of solutions and its simplicity and rapidity recommended it for use in pesticide deposit evaluation. Unfortunately this method will be limited to dust and spray materials containing copper which can be washed from the plant leaves and dissolved in the wash solution. Moreover, it will be useful only in determining the total quantity of material deposited, since such an analysis will give no information about the uniformity of coverage of the leaves. However, if used under the proper conditions, it appeared that the use of this method would make possible the evaluation of copper pesticide deposits in the field in five or ten minutes, a fact that would be very advantageous in studying the efficiency of application operations.

Summary of Titrimetric Technique

1 After the insecticide or fungicide has been applied to the plants, a sample of leaves which represents a definite surface area is taken. This sample may be taken by means of a leaf punch which removes a section of definite area from the leaf. One such punch, reported by Gunkel and Mulligan (3)* is operated by compressed air for rapid sampling. The sample might also consist of all leaves from the plants in a definite length of row.

2 The sample of leaves containing the pesticide deposit is placed in a jar containing a wash solution satisfactory for removing the deposit from the leaf. A suitable method of agitating or stirring the leaves in the solution must then be employed.

3 The leaves are removed from the solution after the deposit has been washed from them. The solution must then be prepared for the analysis process. If the dust or spray material, which contains copper, is not soluble in the original wash solution a method must be devised to dissolve it. The solution must be brought to a neutral or slightly acid condition before beginning the analysis.

4 The actual analysis procedure is begun by adding potassium iodide to the solution containing the unknown amount of copper. The potassium iodide reacts to release free iodine in a quantity of copper present. Following is the equation for the reaction:

$$2\ CuSO_4 + 4KI \rightarrow 2\ CuI + 2K_2SO_4 + I_2.$$

5 A starch indicator is added to the solution which turns a dark blue, denoting the presence of free iodine.

6 A measured quantity of sodium thiosulfate is added which is just sufficient to clear the blue color from the solution. The sodium thiosulfate reacts with free iodine and brings it into a combined state. Thus the cause of the blue color of the starch is removed and the solution clears. This occurs according to the equation:

$$I_2 + 2\ Na_2S_2O_3 \rightarrow 2\ NaI + Na_2S_4O_6.$$

The quantity of sodium thiosulfate added is then proportional to the quantity of copper present in the solution. The quantity of copper present in turn is proportional to the total weight of the material deposited on the leaf surface. Fig. 1 shows the equipment used in carrying out the analysis.

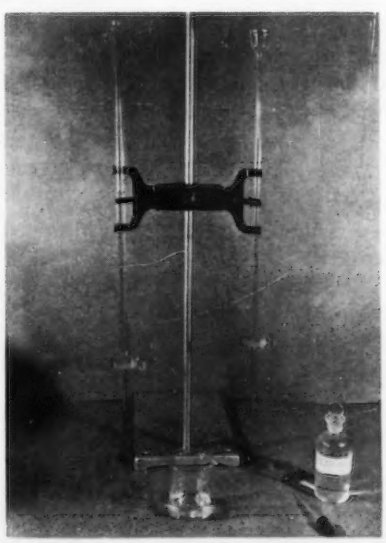

Fig. 1 Equipment used in titrimetric analysis. Potassium iodide was added from the burette on the left and sodium thiosulfate from the burette on the right. Starch was added by means of the medicine dropper in the foreground. This equipment could be set up in the field for rapid deposit evaluation

Development Study

A number of questions needed to be answered and a number of problems needed to be solved before evaluation of copper deposits by sodium thiosulphate titration could be considered practical. Some of these questions and problems were as follows:

- What effect will foreign matter such as will be found on leaves in the field have upon the results?

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The authors—R. W. BRITTAIN, R. D. BRAZEE and W. M. CARLETON—are, respectively, former graduate assistants in agricultural engineering and professor of agricultural engineering, Michigan State College.

Acknowledgment: The authors express appreciation to Erwin J. Benne department of agricultural chemistry, Michigan State College, for his advice, for use of his laboratory for part of their experimental work, and for his suggestions concerning the writing of this paper.

*Numbers in parentheses refer to the appended bibliography.

- Is the titration procedure sensitive enough to detect the small quantities of copper which would be deposited on plant leaves as a part of ordinary insecticides or fungicides?
- A technique for rapidly carrying out the procedure with a minimum of equipment outside the laboratory would have to be developed. This procedure would have to be practical with regard to time, cost, and skill required in its execution.
- An adequate leaf-washing technique would have to be developed. This technique would have to remove a sufficiently large percent of the deposit on the leaf to give consistent results. The washing technique would have to be relatively fast. It would have to either dissolve the pesticide deposit or leave that deposit in such a condition that it could be dissolved afterwards.
- The entire technique would have to be developed for each different material containing copper for which the evaluation was to be used.

The study has been limited to use with hydrated copper sulfate or a bordeaux mixture. A bordeaux mixture consists of hydrated copper sulfate and calcium hydroxide.

After the technique of copper titration was mastered, experimental work was performed to determine the suitability of this method of analysis for evaluating pesticide deposits with regard to *(a)* the effect of foreign matter, *(b)* the effect of calcium hydroxide or hydrated lime found in a bordeaux mixture, and *(c)* the effect of copper adsorption on leaf surfaces, on the accuracy of the analysis. This experimental work was conducted as follows:

1 Solutions containing a known concentration of copper were sprayed on bean leaves. These solutions contained from 1.5 to 6.1 mg of copper per milliliter of solution.

2 Half the solutions contained calcium hydroxide; half did not contain it.

3 The leaves of young tender field beans were placed in the solutions and agitated. No special effort was made to prevent the introduction of foreign matter attached to these leaves.

4 The solutions were then analyzed for copper by the titration technique.

The error in this experimental technique did not exceed five percent. Apparently the introduction of plant leaves and the accompanying impurities did not materially affect the relative accuracy of the procedure. Less error was recorded in the analysis of the solutions containing calcium hydroxide than in those which did not. (This was probably because of the need for initial neutralization of the titration solution containing the basic calcium hydroxide.)

An analysis of variance of the data showed that both the effect of changing the copper concentration of the solution and the effect of adding calcium hydroxide were significant. The results indicated that the stronger the copper solution, the less the error of the method. The addition of calcium hydroxide tended to reduce the error of the method.

The experiment also indicated that the introduction of field impurities and the adsorption of copper on the surfaces of the leaves, as would occur in pesticide deposit evaluation, would not interfere with the accuracy or suitability of copper titration as a method of deposit evaluation.

Two important questions remained to be answered, however. First, the concentrations of copper used in the above experiment were relatively large. The maximum sensitivity of the procedure remained to be determined. Second, a washing technique had to be developed which would provide solutions with a sufficiently strong concentration of copper to permit analysis by this method.

Preliminary investigations relative to the sensitivity of the procedure disclosed that copper concentrations of as little as 0.1 mg in 50 ml of solution could be detected. When known copper concentrations of approximately 1 mg of copper in 50 ml of copper sulfate solution were tested, it was found that a maximum error of ± 0.05 mg of copper was obtained. Leaf samples were washed and the results analyzed by two methods to further test the procedure. In this experiment aliquots of the same wash solution were analyzed both by titration and by polarographic analysis. The two methods of analysis were in agreement to within 0.1 mg of copper when the concentrations were approximately 1 mg of copper in 50 ml of solution.

The washing technique used in the tests was developed for use in evaluating the deposits in special laboratory experiments in which the copper sulfate deposit was larger then normally found in the field. The technique consisted of placing 1 sq in of leaf surface area in 50 ml of distilled water. The wash solution with the leaf sample in it was agitated for thirty seconds. Tests showed that, when leaves washed by this method were washed for the second time, copper could not be detected in the second wash solution by the titrimetric method. As a further check on the thoroughness of the washing procedure, leaves which had been washed once were dry ashed and dissolved in nitric acid. Again the titrimetric analysis did not detect copper. For leaves containing deposits of the order of magnitude of a milligram of copper per square inch of leaf area, the procedure appeared to be adequate.

It should be recognized that plants dusted or sprayed in the field may contain deposits of only 0.1 mg of copper or less per square inch of leaf surface. Therefore, it would require the deposits from perhaps 10 sq in of leaf surface placed in 50 ml of wash solution to give sufficient concentration for titrimetric analysis.

A list of equipment and a detailed description of the procedure may be found in theses by Brazee(1) and Brittain (2).

Conclusions

Titration of copper with sodium thiosulphate solution shows promise as a fast, simple, and inexpensive way to evaluate the deposits of copper-containing pesticides on plant leaves. The procedure, however, has limitations. The advantages, limitations, and points needing further development are as follows:

1 *Rapidity.* The actual chemical analysis can be accomplished in from one to five minutes.

2 *Portability.* All necessary equipment could easily be set up in the field.

3 *Simplicity.* Comparatively little chemical knowledge is required of the operator.

4 *Cost.* All necessary equipment and supplies can be obtained for less than $25. *(Continued on page 323)*

Green Feeding of Livestock

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Nineteenth century soiling system now made practical and economical for modern livestock farms by reason of new developments in forage-harvesting and handling equipment

GREEN feeding is a system of intensive grassland management tried in recent years as a method for increasing farm efficiency. Basically it is the old soiling system of the nineteenth century made practical for modern livestock farms though recent developments in forage harvesting and handling equipment.

Terminology for the system varies with the section of the country. Green feeding or green chop refers to forage crops chopped green, hauled and fed to the animals at some central location. Zero pasture, on the other hand, denotes a system of feed-lot management where fresh green feed, silage and hay are used together or interchangeably as dictated by convenience and economics.

Following are the major advantages of green feeding:

- Increased production per animal
- Increased crop utilization
- Better land utilization
- Simplified farm layout and fencing
- A degree of bloat control not possible under conventional pasture systems.

The first important advantage of green feeding is increased production per animal. Less energy is expended by the animals in moving around the restricted feedlot compared to conventional pasture. Therefore, more of the feed goes into milk or beef production. Milk production can be maintained at a more consistent level without the sharp drop experienced on pasture in dry weather.

Research by the dairy department at the University of Minnesota compared green feeding of an area of alfalfa and brome grass with an equal area in rotational pasture. Preliminary analysis of the results show a 6 percent increase in milk production from green feeding. The 1953 trials at the New Jersey Dairy Research Station showed a 13½ percent increase in average daily milk production in favor of green feeding over rotational grazing. Both stations credited the increase to less variation in daily milk production with cows on green feeding. The Biltmore Farms near Ashville, N. C., have achieved an annual increase of 1,000 lb of milk per cow under their green feeding program.

The second major advantage of green feeding is increased crop utilization. More of the forage produced on the land is consumed by the animals. Selection by the animals is reduced when the less palatable stems are chopped and mixed with more succulent parts of the plant.

The advantages of green feeding in crop utilization are tied in closely with damage to the crop by grazing animals. Green feeding eliminates forage rejection resulting from trampling and manure and urine spots. New Jersey workers estimated that 20 percent of the pasture grass was normally wasted by grazing animals due to trampling, droppings, and overmaturity. In the Rhode Island experiment, the area covered by the droppings was measured. It amounted to approximately 10 percent of the total pasture area. Minnesota observations indicate that the area covered by urine leads to rejection of certain patches in the pasture even after clipping.

The third advantage, better land utilization, is achieved through both higher crop yields and better crop utilization. Milk and beef yields per acre can be substantially increased by growing the right combination of crops on high-producing land, then "grazing" mechanically with a forage harvester. This was demonstrated by the outstanding results of the 1953 Minnesota trials. Although 35 cows on a good rotational grazing plan produced as much milk as the same number on green feeding, only 31 acres were needed to feed the animals receiving green material, compared to 51

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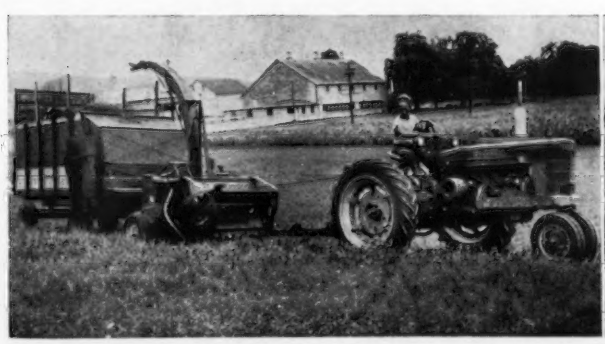

(Left) The field equipment best suited for green feeding is a direct-cut-type forage harvester with a front-unloading wagon pulled behind or beside the harvester and unloaded by the tractor power take-off • *(Right)* Green feeding at the Hershey Farms in Pennsylvania, using a New Holland combination forage box and manure spreader with cross-conveyor attachment to fill the conventional feed bunks

acres for those under the intensive grazing plan. Thus, the milk yield per acre was increased 66 percent with green feeding.

In a California dairy trial, 40 acres of green-cut alfalfa supported 188 cows for 245 days. This was an average of 4.7 head per acre. A total of 1,826 tons of green alfalfa was harvested from this 40 acres. A Florida dairyman is seriously considering the production of green feed for 900 cows on 100 acres.

Green feeding is especially valuable where the forage land is irrigated. Water can be applied when needed without interfering with feeding schedules.

The fourth advantage is simplification of farm layout and fencing problems. Forage from distant fields, too far for pasturing, can be used. Shade and water are needed only in the feed lot rather than in every pasture area. The forage land can be expanded to larger fields for more efficient machine operation. Fences and gates are practically eliminated.

Bloat seems to be easier to control under the green feeding system. Grazing animals will select the succulent top growth so conducive to bloating, but animals receiving chopped green feed eat the fibrous stems along with the tops. Feeding several pounds of dry hay per head each day has effectively reduced bloating in green feed lots. With bunk loading wagons, hay can be mixed with the green material by spreading it on top of the load.

If bloating does occur, losses can be reduced when the herd is in feed lot close to other farm buildings. Affected animals can be discovered and given help more quickly than on pasture.

Following are some of the disadvantages of green feeding:

- Necessity for daily harvesting of green feed
- More critical crop management
- Increased operating and maintenance costs of equipment
- High equipment investment

The greatest disadvantage of green feeding is the necessity for everyday cutting. It introduces another farm chore that must be done 7 days a week in all kinds of weather. However, during a recent experiment at the Hersey Farms in in Pennsylvania, inclement weather stopped the green feed harvesting on only one day. Admittedly the 1954 season was unusually dry in that area.

The second disadvantage is that crop management becomes more critical. High-producing species grown on well-fertilized and well-drained land are essential to this program. Harvesting dates of standard forage mixtures must be planned to overlap with temporary pasture crops, small grains, corn or sorghum to give a continuous supply of green feed.

Daily harvesting increases expenses for fuel and machine maintenance. Good equipment must be used and kept in top condition. A breakdown can mean a delay in feeding and a loss in milk production that can never be regained.

Investment in equipment is often mentioned as a disadvantage to green feeding. In many cases this is not a serious objection because the type of farmer who is interested in green feeding probably has been making grass or corn silage with a modern forage harvester. He may have to buy a direct-cut attachment for his harvester and a self-unloading forage wagon, but both of these implements will be used to advantage in other forage-harvesting operations. More use of this equipment results in lower per hour and per ton costs for all its operation.

Equipment for Green Feeding

When the farm and experiment station experiences are reviewed, some of the probable requirements for good green-feeding practice become evident. The right combination of field and feedlot equipment is essential to efficient operation. If the fields are soft or rolling a tractor of the 35 to 40-dhp size should be available for every-day cutting. The field equipment best suited for green feeding is a direct-cut type of forage harvester with a self-unloading wagon pulled behind or beside the harvester. These units will get the fresh cut material to the feed bunks as quickly as possible. This is important. California work has shown that fresh green feed is about 23 percent more efficient in producing beef than the same material after wilting. This, of course, simplifies the operation since the direct-cut chopper will complete the harvesting with one trip over the field.

Machine maintenance is important to the success of the green feeding program. Breakdowns during the harvesting operation are serious because the animals are waiting to be fed. Rhode Island workers found a drop in evening milk production of 2 pounds per cow when the morning feeding was delayed from the usual 9 o'clock feeding time to 11 o'clock.

The wagon used to haul green feed to the feedlot can be a major key to efficient operation. Self-feeding by the animals directly from the wagon has been successful with small herds. To keep the packed material from heating, Minnesota workers installed an A frame through the center of the wagon which provided the necessary ventilation. However, the feeding area around a wagon is too restricted for more than 20 to 25 animals.

A power-take-off-operated self-unloading wagon is probably the best answer for most operations. A major advantage is its multipurpose use. In addition to green feeding and silage feeding, it can be used in the silage or hay-harvesting operations to provide an even flow of material to a forage blower or elevator.

It is important to know the amount of green feed consumed per animal to determine the type of wagon best suited for a particular operation. Results from farmers and experiment stations vary all the way from 40 lb of green material per animal per day to over 250 lb. The average seems to run between 100 and 180 lb per day for both dairy and beef animals. Some dairy nutrition men feel that a better balance between green feed and other components of the ration will be maintained by limiting green material intake to about 60 lb. per cow per day. More research work is needed to establish the optimum ratio between green feed, silage, hay and grain.

The engineers of our company are developing a cross conveyor for the back of our combination forage box and manure spreader. The multipurpose use and comparatively low cost of this implement may make green feeding practical for smaller herds. This foreage box has a capacity of about 6,000 lb of green material. If daily intake of green feed is 60 lb per animal, one load of chopped material

on this wagon would be sufficient for 100 animals when fed once a day. If a maximum daily consumption of 180 lb is used as the basis for calculations, this combination wagon could handle the feed for 33 animals on a once-a-day feeding program.

For larger operations the 5 and 6-ton special bunk-loading wagons provide the most convenient way to fill bunks at a efficient rate. Our company's new front-unloading wagon is unloaded by tractor power-take-off at rates ranging from 6.5 to 1.8 min per load. Beaters located at the unloading end of the wagon break down the face of the material providing an even flow of loose green feed to the cross conveyor. In the California feeding experiments it was found that these beaters would do a good job of mixing in dry hay spread on top of the load for bloat control.

Feedlot Layout

Feedlot layout is a major timesaver for efficient operation. The feed bunks should be built into the feedlot fence so bunk loading can be done from outside the lot. A long continuous feed bunk allows the operator to drive along the fence line and complete the feeding operation in a matter of a few minutes. Fence-line feed bunks also provide a clear area for more rapid cleaning of the feedlot.

In the Hershey trial, short feed bunks were located within relatively small feedlots. Over half of the feeding time was spent in opening gates, dodging cattle and maneuvering the unloading wagon into position next to the bunks. Bunks should be wide enough to allow for some variation in guiding the wagon and to prevent spilling due to pitching of the material by the cross-conveyor. Backs of the bunks should be high enough so the animals cannot nose out the feed. They should not be too high, for then they interfere with the cross-conveyor. The top should be smooth with no obstructions and the bunks should be joined together to permit continuous filling. Driveways should be level to eliminate tilting of the bed. In some California operations the green feed is placed directly on the ground just outside the feedlot fence. A board about 18 in high and a neck rail under which the cattle can reach to eat is all the equipment needed.

Feeding Practices

Feeding practices have varied from chopping six times a day all the way to chopping three times a week. Once-a-day chopping seems to be the most efficient procedure. When the green material remains in feed bunks or wagons for too long a time, heating in the forage reduces palatability and animal consumption. Good quality hay should be kept in the feedlot, both as a deterent to bloating and to cushion the effects of delayed feeding.

Grain feeding varies with the individual herd. Some dairymen feed no grain when the animals are on green feed, but the most common practice seems to be feeding grain at a grain-to-milk ratio of about 1 to 6.

Conclusions

Drawing conclusions from the experimental work and farm experience with green feeding up to the present time, it can be said that green feeding does offer the opportunity of increasing milk or beef production per unit of land; however, its efficiency depends upon adequate mechanization, good crop management, and labor-saving feedlot arrangement. Some of the men who have been working with green feeding feel that a zero-pasture type of management may prove even more efficient. Hay, silage and green feed are used interchangeably under this system, making it more flexible than continuous green feeding. Limited experimental evidence indicates excellent milk production can be maintained under this combination system.

Other workers feel that the final place for green chopped forage will be as a supplement to pasture rather than as a complete replacement for pasture. Regardless of the direction it takes, green feeding will increase in the future. The speed with which it becomes a generally accepted practice, will depend upon our ability to design new field and feedlot equipment to make the green-feeding operation easier and more economical.

Strain Gages and Stresscoat

(Continued from page 317)

Conclusion

Strain gages with the aid of stresscoat and electronic recording instruments and pickups can be used successfuly to measure such phenomena as static and dynamic forces, torque, pressure, displacement, acceleration, deceleration and time. Accepted techniques now available are being used extensively in the development of farm machinery, and are proving helpful and necessary to the design engineer. These techniques can be considered only as a tool to find a means to an end. The success in the use of such equipment will be only as good, as the skill of the technician in using the equipment and the ability of the engineer to analyze the problem and interpret the results.

REFERENCES

SR-4 Strain gages for stress analysis, Bulletin 279A, Baldwin-Lima-Hamilton Corp., Eddystone, Pa.

Manual on Experimental Stress Analysis Techniques, by W. T. Bean, Jr., and Greer Ellis, Society of Experimental Stress Analysis.

Electric Resistance Strain Gages, W. B. Dobie and P. C. G. Isaac, English Universities Press, Ltd., London, England.

Dusting and Spraying Efficiency

(Continued from page 320)

5 *Versatility limited.* Since the technique is one for copper analysis, it is limited to materials containing copper. It has only been tested for use with hydrated copper sulfate.

6 *Sensitivity limited.* The maximum sensitivity which has appeared practical is ± 0.1 mg of copper.

7 *Indicates total deposit.* This procedure gives no information about the uniformity of coverage of the leaf sample.

8 *Washing technique needed.* A washing technique must be developed which will permit as much as 1 mg of actual copper to be dissolved in 50 ml of wash solution.

9 The effect of field impurities and copper adsorption on leaf surfaces on the accuracy of the method should be determined when the low copper concentrations which have been found possible are used.

BIBLIOGRAPHY

1 Brazee, R. D. Deposition evaluation for agricultural dusting research. Unpublished M.S. thesis, Michigan State College, 1953.

2 Brittain, R. W. The effect of plant surfaces on pesticidal dust deposition. Unpublished M.S. thesis, Michigan State College, 1954.

3 Gunkel, W. W. and C. W. Mulligan Leaf punch for foliage samples, Farm Research, New York State Agricultural Experiment Station, Quarterly Publications, Geneva, N.Y., January, 1953.

Ridge Farming for Soil and Water Control

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A SYSTEM of land management which provides year around protection of the soil from the ravages of water and wind erosion is constantly being sought by agricultural scientists.

Strip cropping, terracing, contour planting, mulch tillage and contour listing are systems of land management which have been tested in Iowa. Some of these systems were found to be practical in certain areas of the state. Research by Browning and Norton (9)* (at the Iowa Agricultural Experiment Station) demonstrated the soil-and-water-conserving value of contour listing. They found that, except in the deep loess soils common to western Iowa, the plant count and yield were generally below that for conventionally farmed corn, that is, plowing, double disking, harrowing, and surface planting.

Table 1 shows the average annual soil and water loss data for a western Iowa loess soil (10). This table shows that two-thirds less soil and one-half less water was lost from the contour-listed corn than from the contour-surface-planted corn. This saving of soil and water was accomplished in spite of the fact that the ridge formed by the lister was not maintained throughout the year but was obliterated by the second cultivation when the soil was thrown to the corn plant for weed control.

The detrimental effect of erosion is even greater than soil loss data would seem to indicate because (5, pp. 8.16 and 12) the eroded particles contain a higher percentage of plant nutrients than the original soil and these nutrients are often much more available.

System of farming holding much promise for protecting soil from water and wind erosion, for reducing drowning in areas needing drainage, and for lowering labor and power requirements

TABLE 1. AVERAGE ANNUAL SOIL AND WATER LOSSES FROM CORN LAND AS AFFECTED BY CROPPING SYSTEMS. Ida silt loam, 1948-52

Rotation and method of planting	Soil loss tons per acre	Runoff, inches
Corn-oats (sweet clover catch)		
Surface planted up-and-down-hill	30.44	4.02
Surface planted on the contour	10.84	2.78
Contour listed	3.37	1.65
Corn-oats-meadow-meadow		
Contour listed	1.79	0.95

Total average annual rainfall on the Western Iowa Experimental Farm, 29.15 in; slope, 14 percent; length of slope, 72.6 ft (Reference 10).

A study of bed-farming practices used for the production of cotton and tobacco and other high-value crops indicated several advantages of the elevated ridge, such as drainage of the ridge, high-capacity equipment and low total power requirement per acre for seedbed preparation.

A review of the literature concerning corn production in the corn belt showed that Jones and Beasley (7) at the Missouri Agricultural Experiment Station conducted ridge-farming experiments for three years starting in 1938. They found decreases in yields which were offset in part by reductions in labor requirements. The experiment was abandoned due to inadequacy of equipment to construct and cultivate ridges.

Shortly after World War II, many new herbicides were put on the market. The phenomenal sales and use of the materials, particularly 2,4-D, are indicative of their effective-

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*Numbers in parentheses refer to the appended bibliography.

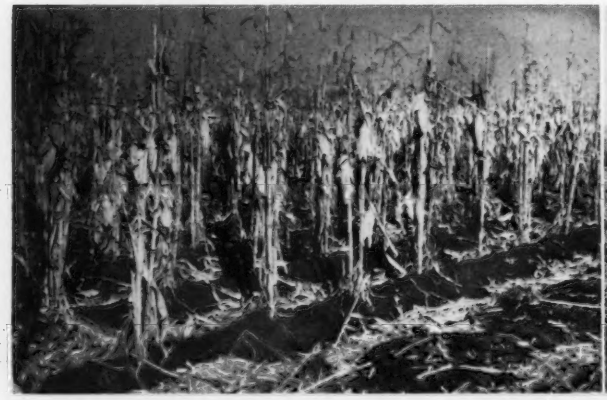


Fig. 1 *(Left)* Mature ridge-farmed corn grown in 1953 • Fig. 2 *(Right)* Plowing ridges with International Harvester C tractor and modified two-way moldboard plow

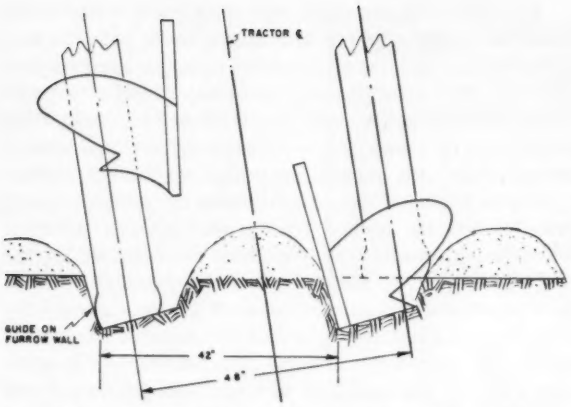


Fig. 3 *(Left)* Wheel spacing of the International Harvester tractor shown plowing ridges in flat land

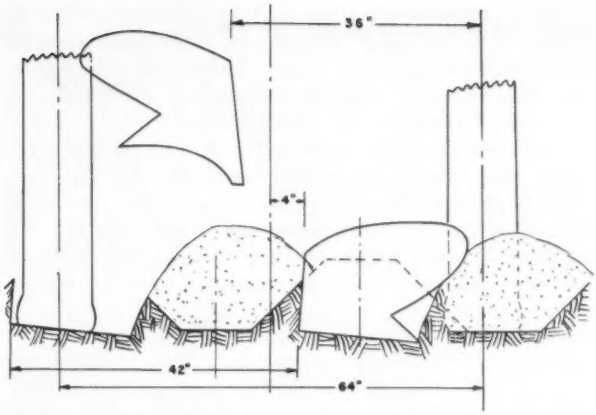


Fig. 4 *(Right)* Wheel spacing of Ford tractor shown reversing ridges formed the previous season

ness. In 1946 agricultural engineers of the Iowa Agricultural Experiment Station and U.S. Department of Agriculture started research experiments on equipment and methods of applying herbicides to control weeds.

Lovely *et al.* (8) reported on the use of flame cultivation, pre-emergence and postemergence applications of 2,4-D to control weeds. Results indicated that a pre-emergence application of 2,4-D gave excellent early control of annual grasses and most broadleaved weeds. This spray, applied at time of planting, retarded the growth of annual grasses and prevented the growth of susceptible broad-leaved weeds for a period of four to five weeks.

The normal, early mechanical cultivations were eliminated and efficient weed control was obtained with two cultivations, the first being done when the corn was 12 to 15 in high.

DEVELOPMENT OF MACHINERY AND CULTURAL METHODS

Based on the following factors a modified system of ridge farming was evolved: pre-emergence weed control, effectiveness of the contoured furrow in soil and water control, and the tillage capacity of the lister (which actually tills one-third of the land). This system, proposed by E. V. Collins (8 and 1), consisted of planting on contoured ridges, pre-emergence spraying to control early weed growth and mechanically cultivating to control late weed growth. By adopting this system the ridges were maintained throughout the year. Fig. 1 shows a field of mature ridge-farmed corn.

For the past four years agricultural engineers of the U.S. Department of Agriculture and the Iowa Agricultural Experiment Station have conducted ridge-farming investigations at several locations in Iowa. Methods and equipment for growing corn, soybeans, oats, grasses and legumes on ridges were studied.

A machinery program was initiated in 1951 to develop farm machinery which would economically transform the above principles into actual farming practices. The following paragraphs contain a report on the machines currently being used to grow corn on ridges and their operating characteristics.

During the first season, a two-bottom lister was used to construct contoured ridges. It was found unsatisfactory because it formed pairs of furrows, whereas pairs of ridges were required to facilitate accurate planting and cultivating. Another fault of the lister was that it placed the crop residue in a vertical plane extending up through the middle of the ridge where the planter runner was to operate. The crop residue interfered with the operation of the planter and cultivator. Poor stands resulted when seeds were planted in this crop residue.

The moldboard plow operating at a depth of about 8 in was found to construct satisfactory pairs of ridges approximately 15 in high. When a 42-in row spacing was used, a 14-in plow bottom placed the furrow slice on 28 in of untilled soil. In this manner the power requirement was reduced to approximately one-third that of conventional

Fig. 5 *(Left)* Plowing ridges with Ford tractor and modified two-way plow

Fig. 6 *(Right)* Ford tractor pulling disk bedder and treader

plowing. By using a two-way plow the operator could turn around at the end of the row and return by guiding on the landside of the previous furrow. Time spent at row ends was thus held to a minimum and accurate parallel paired ridges were constructed by this procedure.

The two-way plow shown in Fig. 2 was modified to increase plow-bottom suction and beam clearance. As supplied by the manufacturer, the front end of the plow beam scraped off the top of the previously formed ridge and did not have sufficient suction for deep plowing. Fig. 3 shows the wheel spacing for the International Harvester tractor plowing flat land.

The Ford two-way plow shown in Fig. 5 made satisfactory ridges after it was modified by adding trailing-hitch adapters (3) to provide a higher lift so the up-bottom could clear the previously formed ridge. Fig. 4 shows the wheel spacing on the Ford tractor that was used to plow ridges in flat land and to reverse ridges made the previous season. Reversed ridges as shown in Fig. 4 were made by inverting the old ridge with a plow. The soil was placed in the adjacent furrow.

Nitrogen fertilizer was applied during the ridge-plowing operation. The fertilizer was dropped just ahead and slightly to the landside of the down-plow bottom. Conventional starter-fertilizer equipment supplied with the planter was used. A shutoff was required on each hopper to distribute fertilizer only under the ridge being formed. Fertilizer dropped during the reversing of ridges was placed at a depth of 10 to 14 in. This system provided an economical method for deep placement of fertilizer on top of the crop residue. Consequently, both fertilizer and the completely covered crop residue were located approximately in a horizontal plane below the turned furrow slice.

After plowing, the ridges were left in the rough state until planting time; however, if weed control were a problem, or if the ridges were constructed just prior to planting, the ridges were tilled with a tool-bar disk bedder or a disk cultivator. On loose or cloddy soils, the treader (rotary hoe pulled backwards) was pulled behind the disk bedder to firm the ridge. Fig. 6 shows the disk bedder and treader.

The ridges were planted with a mounted two-row planter equipped with single-disk furrow openers. The disk cut through the surface trash and did not clog as had a previously tested stubrunner furrow opener. (The stalks clogged on the runner, scraped off the top of the ridge, and materially reduced the height of the ridge). The conventional open-centered presswheel was found to satisfactorily firm the soil over the seed on the ridges.

Fig. 7 Side view of cultivator equipped with disk hillers

After planting, the entire land surface was sprayed with 1½ lb of 2,4-D ester per acre mixed in 10 gal of water. Self-propelled and tractor-mounted sprayers were used to apply the spray after planting; however, a sprayer mounted on the planting tractor could have been used to spray during the planting operation. An application of 2,4-D at the above rate, after the corn has emerged, may cause serious damage to the corn plant and reduce yields; therefore, pre-emergence sprays should be applied before the corn has emerged. When the corn plants were about 14 in in natural height, the 2,4-D had begun to lose its effectiveness and the stunted grass was starting to recover. Because of the height of the corn, the cultivator could be and was operated at speeds much higher than normal for the first cultivation. The cultivator (Fig. 7) was equipped with four disk hillers per row using 12-in disks in front and 16-in disks in rear. The front disks were staggered (11) with respect to each other and were set at an approximate 15-deg angle with the row and about 4 in above the rear disks. This slight angular set of the front disk-hillers caused the disks to push the soil rather than lifting and throwing it into the row.

PHYSICAL-CHEMICAL ENVIRONMENT OF THE ROOT BED

Extensive field and laboratory measurements of soil temperature, soil moisture, bulk density, and available nutrients were made on ridged and listed plots. These measurements were used *(a)* to determine the environmental conditions of the root bed, *(b)* to indicate changes which would improve the conditions and *(c)* to correlate with yield and plant count data so that an early conclusion could be reached concerning the value of the various practices.

Moisture Content

It was a common observation that, after each rain, the surface of the ridge dried ahead of that of the furrow because of its greater elevation. The height of the ridge established a moisture tension of approximately 30 cm which is equivalent to one-half of that required for the drainage of the soil macropore space. This tension was sufficient to cause rapid drainage of the ridge after a rain and reduced the period of saturation of the root zone. Thus the time the seed or its seedling must spend in a wet soil is deceased.

Fig. 8 shows an average soil-moisture profile for the ridge, furrow and traveled furrow between ridges during the latter part of June. A statistical analysis of the data showed that there was no real difference in the total moisture contents between ridge and lister farming; however, an analysis would probably show real differences in the moisture contents at some specific depth, such as 5 in below the soil surface.

It was noted in Fig. 8 that the maximum moisture content of the ridge was at the 7-in depth while that of the lister furrow was at the 4-in depth. Considering the ridge to be approximately 12 in high at time of sampling, the point of maximum moisture content of the ridge was found to be 9 in above the similar point in the furrow. It was thus apparent that the isomoisture lines of the soil (lines joining points of equal moisture content) approximated, with a smaller amplitude, the soil surface profile.

Temperature

The better draining of the ridge contributed to the reduction of the specific heat of the soil. The reduction in specific

heat was one of the reasons the root bed of the ridge heated to a higher temperature than the root bed of the furrow. A given quantity of radiation increased the temperature of the surface soil of the ridge more than the furrow. It should be noted that (except during early morning and late evening on north-south rows) the ridge and furrow received the same quantity of radiation. The soil temperature of the ridge at the 3-in depth was found to be 1 to 8 F warmer than the equivalent depth in the furrow and slightly warmer than the 3-in depth in the flat-planted row. Fig. 9 shows an average soil-temperature profile of the ridge and furrow for the growing season. The temperature differential was greatest at the surface and decreased with depth. Continuous 24-hr studies of the temperature cycle showed that the temperature at any depth in the ridge was always higher than the equivalent depth in the furrow. At the 3-in depth, the maximum temperature was reached at 4:30 p. m. in both the ridge and furrow.

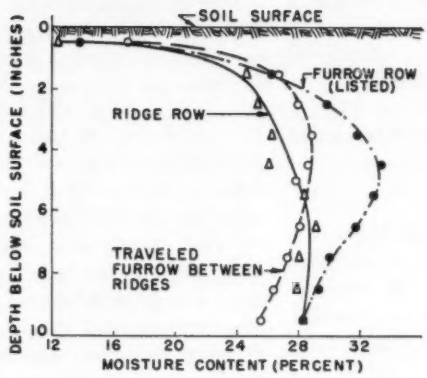
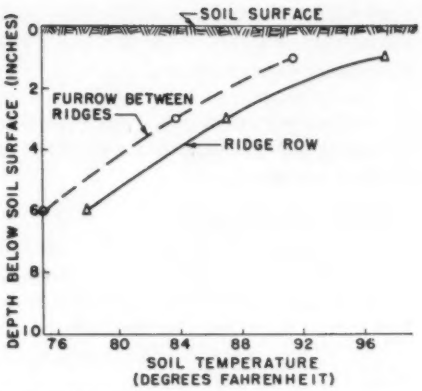


Fig. 8 *(Left)* Soil-moisture profile • Fig. 9 *(Right)* Soil-temperature profile



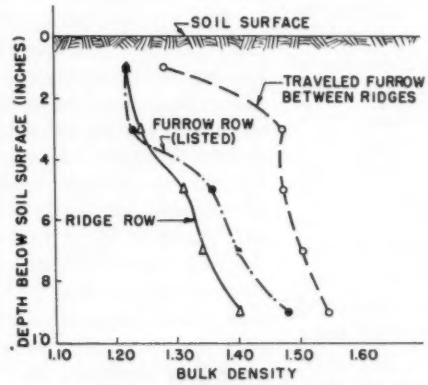
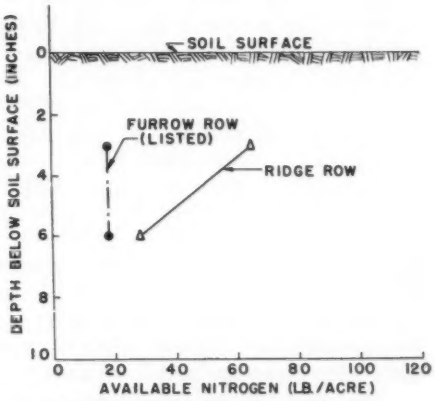


Fig. 10 *(Left)* Bulk-density profile • Fig. 11 *(Right)* Available-nitrogen profile



As the temperature of the soil water increases, the viscosity and surface tension decrease and the vapor tension and rate of evaporation increases. The above factors explain the inverse relationships in the soil between temperature and the moisture content at field capacity (1) and temperature and the capillary conductivity.

The rapid draining and drying of the ridge noted previously prevented an extreme loss of moisture by evaporation. The capillary conductivity of the warmed crust was so reduced that the water lost by evaporation could not be replaced fast enough by capillary flow to maintain film contact between the soil particles. Thus the higher temperature of the ridge contributed to the further drainage of the ridge as well as evaporation of water from the surface of the ridge.

This higher soil temperature combined with the good drainage characteristics of the ridge increased the rate of emergence and the total germination of the planted seed. Stands were found to be consistently more uniform on ridge-farmed plots (1).

Structure

The physical condition of the soil was evaluated by determining the bulk density of each 1-in layer of the upper 10 in of the soil.

Fig. 10 shows the bulk-density profiles of the ridged row, listed furrow and the traveled furrow. Wheel travel was found to compact the soil in the furrows. The slow drying of the furrow contributed to this problem as the ridge could be and often was planted and cultivated when the furrow was actually too moist to till. Comparing the bulk-density profiles of traveled furrows and listed furrows with the soil-moisture profile shown in Fig. 8 indicated that compaction due to wheel travel materially reduced the amount of water entering the furrows.

The apparent packing action of the lister bottom during the forming of the furrow increased the bulk density at the lower depths. This compaction reduced the downward movement of water and resulted in, as shown in Fig. 8, a decrease in moisture content with depth below the maximum moisture zone.

Available Nutrients

Fig. 11 shows the available-nitrogen supply as determined by soil tests in the ridge and listed-furrow rows during the latter part of June. The addition of a starter fertilizer increased the available nitrogen supply in the ridge row and lister furrow (1). The increase in available nitrogen over and above that of the unfertilized plots at the 3 and 6-in depth for the ridge row and lister furrow was 18.2, 8.4 and 6.2 5.0 lb per acre, respectively. One or more of the following reasons could account for the higher nitrogen supply in the ridge: *(a)* The higher temperature increased the rate of nitrification due to the increased activity of the bacteria; *(b)* soluble nutrients were dissolved in the water accumulating in the lister furrows and were carried from the field in the runoff water, and *(c)* the available nutrients were leached from the soil by the water infiltrating through the

lister furrows into the subsoil. The application of 2,4-D pre-emergence spray did not in any way affect the amount of available nitrogen in the soil.

The application of starter fertilizer increased the quantity of available potassium in the ridge and furrow (1). The act of ridging did not improve the supply in plots where starter fertilizer was not applied.

Other Physical Factors

The elevation of the ridge as described by Hilgard (6) provides a chimmey effect for the ready escape of air from the soil when water enters the soil through the furrow. This avenue of escape decreases the compression of the soil air and reduces the part it plays in lowering the infiltration capacity of the soil.

Compaction of the furrows by wheel travel plus the reduction of the wetted perimeter between the accumulated water and the surface of the furrow tended to decrease the infiltration capacity of a ridged field. Fig. 12 shows a ridged plot of the contour-tillage experiment. This picture shows water, after a 1½-in rain, standing in furrows compacted by wheel travel. The wheels of the wide front-end tractor operated in alternate furrows during the farming operations. The horizontal flow of water through the ridge from the traveled furrow to the untraveled furrow permitted water not infiltrated in one furrow to move laterally to the adjacent furrow; however, the fact remains the only water lost from the field was lost from the traveled furrows. No water was found standing in the flat planted plots, but three areas were found where erosion had occurred. The erosion washed out numerous hills of corn and carried soil from the field.

The effect of compaction upon infiltration capacity is shown when Figs. 8 and 10 are compared with Fig. 12. Reduced travel, fewer operations with multiple equipment and plowing out of the tractor tracks should improve the infiltration capacity of the furrows.

OBSERVED BENEFITS OF RIDGE FARMING

During the development of the cultural practices, a number of problems associated with other systems of farming such as drowning and sidehill slippage were eliminated by the intrinsic characteristics of ridge farming.

The height of the ridge ranges from approximately 15 in at the time of plowing to 10 in at harvest time. A ridged field laid out on the true contour will have as a minimum 5 in of aboveground water storage capacity; however, when the grade is slightly irregular, the aboveground capacity may be reduced to about 2 in of water. This storage capacity (2 in) plus the infiltration of water into the soil will store a high percentage of the rains.

Calculations of the cross-slope carrying capacity have been made on furrows 1000 ft long. Water moving at a depth of 2 in in the above furrows graded to a 0.5 percent slope can carry 2.2 in of water per hour from the field.

The ridge-furrow combination provided an accurate steering guide for planting, cultivating and picking. The front wheels of the tractor tended to follow the furrows of previously formed ridges. The ridges prevented sidehill slippage of tractors and implements. This minimizes the careful attention normally required for the first cultivation of contoured rows and permits higher operating speeds for later cultivations.

During the picking of corn, the furrows helped the equipment to follow the contour. While picking the curved portions of contoured ridged rows, the rear guide wheel of self-propelled equipment often rode on the sloping portion of the ridge. The differential brakes were used at times to prevent the rear guide wheel from crossing the ridge. The tapered ends of the stalk-gathering points of the corn picker were located in the furrows below the base of the plant. This permitted the points to gather and lift lodged stalks.

Observations indicated that there was a certain amount of weed control derived from the effect of splash erosion of raindrops. The soil was undermined from the base of the grass seedlings and carried down slope to the furrow. The root-killing effect of the 2,4-D pre-emergence spray combined with the undermining of the root system had a tendency to stunt the grasses and contributed to the ease with which the first mechanical cultivation controlled the grasses.

As stated previously, during the ridge-plowing operation one section of top soil is placed upon another section of untilled top soil. This procedure permitted the accumulation of top soil and provided a deeper seedbed. This is especially beneficial in thin land.

On level poorly drained land the elevated seedbed of the ridge provided a certain amount of protection against drowning of the crop during flooded conditions. It has been observed in several low spots that the ridged seedbed was inundated for a shorter period of time than the flat planted

Fig. 12 *(Left)* Water standing in the furrows after a rain where the tractor had traveled approximately twelve times • Fig. 13 *(Right)* An air view of a 120-acre field of ridged land (foreground), showing the correction strips (generally horizontal lines) and waterways (generally vertical lines)

seedbed. The reduction of the inundation period prevented the drowning of ridge planted crops during the 1951 and 1954 crop years.

FIELD LAYOUT FOR CONTOUR RIDGE FARMING

The field layout of contoured ridges was similar to that used for contoured listed furrows and contoured surface planted rows. Basic information pertaining to design and layout of contoured listed furrows and parallel terraces was utilized in the contour ridge farming field layout. In addition to the normal layout, it was necessary to locate level areas (either grassed or surface planted) at all row ends to facilitate turning. Waterways were established to carry water in natural draws, to aid turning where sharp bends occurred in contour lines and to break long rows into lengths of 1000 ft or less.

Both terraced and unterraced fields have been contour ridge farmed. Ridges were constructed down the slope parallel to the upper terrace so that all of the point rows drained into the lower terrace channel. A grassed or surface-planted turn alley was located in the lower terrace channel. The through rows drained into the grassed waterways. By plowing ridges down the slope from the upper terrace the furrows will almost always drain to the waterways.

In an unterraced field parallel ridges were constructed above and below a guide line with a 0.5 percent grade. The furrows above the guide line decreased in grade until grade reversals occurred. These grade reversals forced the water to accumulate in the ridge furrow and caused overtopping and failure of the ridges.

True contour guide lines without grade were established in another unterraced field. An air view of this field is shown in Fig. 13. The generally horizontal lines are correction strips and the generally vertical lines are waterways. The top guide line was located about 5 ft in vertical interval below the highest point in the field. The criterion for establishing the succeeding contour guide lines laid out down the slope was based on limiting the grade in any furrow to 4 percent for a distance of no more than 100 ft. Steeper grades in furrow channels were used for shorter rows. A grassed correction strip or turn alley was seeded above each contour guide line. Ridges were constructed down the slope parallel to the guide line so that all point rows drained onto a lower grassed correction strip. In the area above the top guide line as shown in Fig. 13, the ridges were constructed parallel to the north-south road without regard to contour. Many of the straight rows drained to the correction strip above the top guide line. Due to the large amount of runoff from these straight rows, the contour ridges below the correction strip were overtopped during a heavy storm. A number of downslope ridges successively failed until sufficient capacity was developed to store the water dumped by the straight rows or until several furrows with sufficient grade to a waterway were encountered.

In addition to the above failure, other field observations have been made on overtopped ridges below correction strips. In every case, the ridge-furrow combination prevented the erosion of the entire slope. A portion of the soil from the eroded ridges was found deposited in the furrows below the failed ridges.

Experience has shown that the ends of the rows should be turned down slope to provide drainage for the furrows. The grassed waterways and correction strips were 30 ft wide to facilitate turning and were interconnected to simplify hay harvest.

YIELDS

Experiments were designed to provide yield data on ridge, lister and conventional farmed plots. These data are summarized in Table 2.

TABLE 2. YIELD OF CORN PRODUCED BY DIFFERENT SYSTEMS OF FARMING

Year	No.	Soil type	Topography	Listed	Farming system, bushels per acre	
					Ridge	Conventional
1952	1	Clarion-Webster*	Level	44.3	66.8	79.7
	2	Clarion-Webster	Level		101.0	111.0
	3	Clarion-Webster*	Level	77.9	82.1	98.3
	4	Loess	Sloping	122.0	126.0	
1953	5	Clarion-Webster*	Level	52.0	63.0	63.8
	6	Clarion-Webster	Level		70.8	71.8
	7	Clarion-Webster	Level		73.0	65.0
	8	Loess*	Sloping	94.7	82.6	
1954	9	Clarion-Webster	Level	71.3	65.3	72.6
	10	Clarion-Webster	Sloping		33.7	38.8
	11	Clarion-Webster	Level		46.0	41.4
	12	Carrington Clyde	Level		50.4	61.3

*Yield differences were significant at the 5 percent level. All plots were harvested with a single-row picker.

Inspection of Table 2 shows that yields were fair to high in 1952 and 1953 but were low in 1954. The low yields in 1954 were due to the unusual weather conditions. By statistical analysis, significance between farming methods was found at the 5 percent level on the Clarion-Webster soil in 1952 and 1953 and on the loess soil in 1953. With the exceptions of 4, 8, and 10 all of these experiments were on level land.

The data indicates that highest yields were produced on the conventional farmed plots. It should be pointed out that conventional farming on sloping land permitted soil erosion and that yields would decrease as the top soil becomes depleted over a period of years.

In all cases, except experiment 1, yields from ridge-farmed plots were similar to yields from conventional-farmed plots. The differences were not great enough for significance at the 5 percent level.

On Clarion-Webster soil in 1952 and 1953 yields produced by listing were significantly lower than those produced by conventional farming. In experiments 1 and 5 yields from listed plots were significantly lower than yields from the ridge farmed plots.

The yield difference shown in the 1953 experiment on loess soil are not indicative of results obtained under normal crop management.

SUMMARY AND CONCLUSIONS

This study was initiated in 1951 to develop the machinery, tillage and cultural practices used in the ridge-farming system. The primary objectives were to develop a system of farming that would effectively control soil and water losses and continuously maintain high yields. The results were compared with lister and conventional farming.

The moldboard plow constructed a better ridge than the lister. It placed the crop residue below the plowed furrow slice and provided an economical method for deep placement of commercial fertilizer. *(Continued on page 331)*

Pelleting Grain and Hay Mixtures

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Member ASAE

PELLETING of rather finely ground grain and other components, mainly feed concentrates, has been a fairly common practice for some time. Although poultry and dog feeds are probably most frequently pelleted, many other feeds are also available in the form of small pellets. The use of mixed-feed pellets offers several advantages over similar components fed in the loose, ground state. The feed pellets are less dusty, pour readily, and are not subject to sorting by the consuming poultry or animal.

Putting a forage crop such as alfalfa or clover in the pellet form has similar advantages. Separation of leaves and stems and subsequent leaf loss practically can be eliminated. Pelleted forage can be transported, loaded, and unloaded with conventional ear-corn conveying equipment, frequently more readily than ear corn can be handled. The storage space required for pelleted forage is about one-fifth or one-sixth that required for chopped or long hay (Fig. 1). Forage pelleted at a moisture content too high for storage can be dried readily by common drying procedures similar to those now used for long hay and ear corn.

The digestive system of the dairy cow is such that it is desirable that the bulk of the forage feed be in a rather coarse physical state (1-5).* To meet this requirement forage to be pelleted should not be ground previous to the pelleting and also should not be ground in the pelleting process. Thus small pellets made by conventional roller-type pellet mills were not considered satisfactory.

An experimental hydraulic pellet press was set up at the Wisconsin Agricultural Experiment Station (agricultural engineering department) to produce pellets of chopped or long forage. Pellets of various sizes ranging from 1¼ to 2½ in in diameter have been made. Most of the work has been done with cylindrical pellets 2 in in diameter and 1½ to 2 in long. Contrary to popular belief, no supplementary binding agent seems to be necessary, and almost any fairly dry material can be pelleted if enough pressure is applied. Alfalfa, clover, and brome grass all pellet well, either alone or mixed (Fig. 2). More leafy material makes a smoother and more dense pellet.

Ground small grain and corn pellet well in the large size, but these pellets are not nearly as durable when handled as alfalfa and clover pellets. If the corn and grain are not ground, the pellets tend to break up rather easily. Higher pressure might minimize this difficulty, but we did no further work along this line because it did not appear to offer many possibilities.

Any reasonable dairy-cattle ration of either whole or ground grain or shelled corn and alfalfa could readily be formed into a pellet with good handling qualities. Pelleting the complete dry ration may have considerable advantage where cattle are being self-fed. Such a procedure, of course, necessitates having all the components of the ration available to pellet at one time and would probably require pelleting later in the season than the time for normal forage harvest. It is believed that the greatest advantage in pelleting forage could be realized by the use of a portable field machine which would pellet forage from the windrow at a moisture content above that at which serious leaf shattering takes place.

In our limited experiments we have found that alfalfa can be successfully pelleted at moisture contents of 30 percent or less. At higher moisture contents the pellets expand considerably after removal from the press and in the drying process. At a moisture content of about 50 percent and above, alfalfa acts essentially as a fluid when subjected to high pressure in a pelleting cylinder. The pressure required to form a reasonably stable pellet seems to vary in an inverse ratio to the diameter of the pellet.

A pressure of 4,000 lb per sq in of cross section produces a pellet in the 2-in-diameter size that stands considerable handling. The actual pellet density at this pressure is about 40 lb per cu ft for No. 1 alfalfa (Fig. 3). These pellets have been readily consumed by cattle on feeding trials. Pellets made at lower pressures tend to break up more on handling and, of course, require considerable more

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*Numbers in parentheses refer to the appended bibliography.

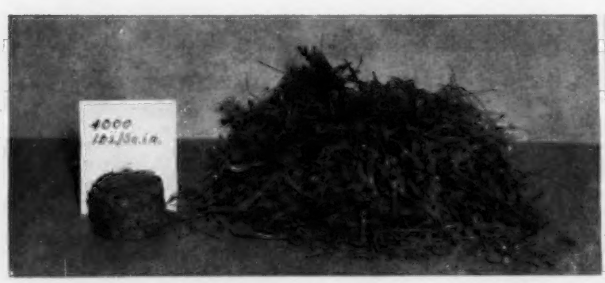

Fig. 1 *(Left)* The volume reduction in pelleting loose chopped alfalfa is indicated in this picture. The weight of the loose alfalfa is equal to that of the 2¼ x 1¼-in pellet • Fig. 2 *(Right)* Alfalfa, clover, and brome grass all can be put in pellet form either separately or in mixtures. These pellets, 2 in in diameter and about 1 in thick, are a mixture of alfalfa and brome grass. The pelleting pressure was approximately 4000 lb per sq in of cylinder area

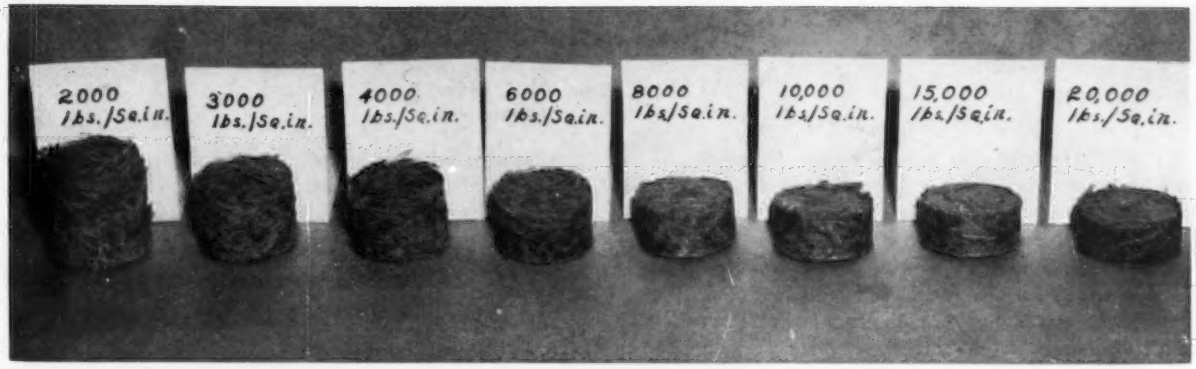

Fig. 3 The relative density of pellets with respect to the pressure applied in pelleting is indicated in this picture. These 2¼-in-diam pellets are all of equal weight. A pelleting pressure of 4,000 to 6,000 lb per sq in appears to be a practical range

storage space. Higher pressures produce more dense and more durable pellets. The cattle seem to experience difficulty in eating pellets made at 8,000 to 10,000 lb per sq in pressure (50 to 60 lb per cu ft, actual density) but in spite of this difficulty they ate the pellets which were made of high-quality forage quite readily. Such high-pressure pellets would, however, probably not be desirable for feeding purposes.

A pellet ejected from the press immediately after pressure is applied seems to expand more after ejection and does not stand handling as well as a pellet held in the press for a short period of time. The exact relationship of this and many other factors have only been studied in a very limited way, and a satisfactory portable pelleting machine which could be sold at a price that the average farmer can afford is undoubtedly, a long way off. However, the over-all procedure appears to have tremendous possibilities in reducing labor, maintaining high-quality feed, and reducing the cost of storage structures, feed-handling equipment, and long-distance transportation.

BIBLIOGRAPHY

1 Allen, N. N. Unpublished data and personal communications.

2 Balch, C. C., Balch, D. A., Bartlett, S. and Rowland, S. J. Diet and low fat content in milk. Proc. 13th International Dairy Congress, The Hague. 49-58, 1953.

3 Powell, E. B. One cause of fat variation in milk. Proc. Amer. Soc. Animal Prod., 40-47, 1938.

4 Powell, E. B. Some relations of the roughage intake to the composition of milk. *J. Dairy Sci., 22,* 453-454, 1939.

5 Tyznik, W. J. The effect of the amount and physical state of the roughage upon the rumen fatty acids and milk fat of dairy cows. Ph.D. thesis, Univ. of Wis., 1951.

Ridge Farming

(Continued from page 329)

When necessary, additional seedbed preparation was accomplished with conventional tool-bar bedding tools or disk cultivators. Treaders were used to firm the seedbed if planting were done immediately after ridges were constructed.

The use of pre-emergence applications of 2,4-D made ridge farming practical by retarding weed growth until the corn was 12 to 15 in high. Conventional sprayers were used. At this stage of growth the delayed first mechanical cultivation continued to control weeds by covering them with soil. The cultivation also increased the height of the ridge. The most successful cultivating tool was a tractor-mounted cultivator equipped with disk hillers.

Physical and chemical measurements of the environmental conditions of the root bed of the ridge, lister furrow and traveled furrow between the ridge were made in the field and in the laboratory. The results of these studies are as follows:

- The elevation of the ridge contributed to its rapid drainage; less moisture was found in the upper portion of the ridge.
- The specific heat of the ridge soil was reduced by drainage. As a result of this, the ridge warmed to a higher temperature than the furrow.
- A larger quantity of available nitrogen was found in the ridged seedbed.
- Wheel travel compacted alternate furrows and apparently reduced their infiltration capacity.

Field layouts for contour ridge farming were successfully accomplished on both terraced and unterraced fields.

Growing corn on ridges (ridge farming) provided aboveground water-storage capacity, reduced water runoff and soil erosion, and produced yields equal to those obtained by conventional practices.

BIBLIOGRAPHY

1 Buchele, W. F. Ridge farming and plant root environment. Unpublished Ph.D. thesis, Iowa State College Library. 1954.

2 Carnes, A. Soil crusts. Methods of study, their strength, and method of overcoming their injury to cotton stand. AGRICULTURAL ENGINEERING 15:167-169, 171, 1934.

3 Collins, E. V. A new hitch for rear-mounted tractor equipment. AGRICULTURAL ENGINEERING 32:211-217, 1951.

4 Duley, F. L. Surface factors affecting the rate of intake of water by soils. Proc. Soil Sci. Soc. Am 4:60-64, 1939.

5 Frevert, R. K., Schwab, G. O., Edminster, T. W. and Barnes, K. K. Engineering in soil and water conservation. Ann Arbor, Mich. Edwards Brothers. (lithoprinted) 1953.

6 Hilgard, E. W. Soils, their formation, properties, composition and relations to climate and plant growth. New York. The MacMillan Co. 1906.

7 Jones, Mack M. and Beasley, Robert P. Corn tillage studies on rolling Putnam silt loam. Mo. Agr. Exp. Sta. Bul. 475. 1945.

8 Lovely, W. G., Sylwester, E. P. Staniforth, D. W., Collins, E. V. and Bakke, A. L. How to control weeds in corn. *Iowa Farm Sci.* 6:185-188. 1952.

9 Norton, R. A., Browning, G. M., Bower, C. A. and Davidson, J. B. Plow testify again. Farm Sci. Rep 6:3-6 Iowa Agr. Exp. Sta. 1945.

10 Schaller, F. W. Annual progress report. Western Iowa Exp. Farm. Iowa Agr. Exp. Sta. FSR-70. 1952.

11 Shedd, C. K., Collins, E. V. and Davidson, J. B. Weed control in growing corn. Iowa Agr. Exp. Sta. Bul. P44. 1942.

12 Stoltenberg, N. L. and White, J. L. Selective loss of plant nutrients by erosion. Proc. Soil. Sci. Soc. Am 17:406-410. 1953.

Radial Air Flow Resistance of Grain

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MUCH useful data has been presented by Shedd (1, 2)* giving the pressures required to force various volumes of air through different grains. All of Shedd's measurements were made in columns of grain in which the air-flow paths were parallel and therefore apply directly to parallel flow systems such as bins with perforated, raised floors or columns of grain contained between parallel, perforated walls. By computation they may be extended to arrive at approximations in convergent or divergent air flow such as occurs in systems employing one or more air ducts. However, such computations may become exceedingly laborious and they require knowledge as to the patterns of the air-flow lines through the grain.

This paper presents a mathematical equation which satisfies most of Shedd's data and shows how it can be used to determine pressure patterns for radial flow of air in grains. Also presented is a laboratory procedure designed to observe, experimentally, radial and non-linear flow patterns. Results obtained are compared with those derived by use of the equation developed and Shedd's data.

Shedd's data can be applied to radial flow if the relation between air volume and pressure can be expressed as a mathematical formula. Shedd (2) mentions the possibility of expressing this relationship by the equation†

$$V = c\Delta P^k \quad . \quad . \quad . \quad . \quad . \quad [1]$$

in which

V = air flow, cubic feet per minute per square foot of area

ΔP = pressure drop per foot depth of grain, inches of water

c and k = constants for any one lot and condition of grain.

He shows that equation [1] applies approximately for only narrow ranges of values of V, and therefore that the utility of the equation is questionable. Further examination of Shedd's data, however, shows that an equation of the form

$$\Delta P = \frac{a V^2}{\log_e (1 + bV)} \ddagger \quad . \quad . \quad . \quad [2]$$

can be used to express the relation between apparent velocity, V, and pressure drop, ΔP, with good accuracy throughout the range of velocities reported, by proper selection of the constants a and b.

In checking equation [2] against the observed pressures and velocities, all of the grains in Shedd's report for which the data extended over the range $V = 2$ to 40 cfm per sq ft were used. Values of a and b were assigned which would compute to the observed pressure at 40 cfm per sq ft and as nearly as possible to the observed values at 2 and 10 cfm. Table 1 shows the values of a and b and compares the computed and observed pressures for the 13 grains for which Shedd's data cover the entire range from 2 to 40 cfm. The data on the remaining grains extended over a shorter range of velocities and any failure of equation [2] would not show up so well. Examination of the table shows that equation [2] may be used to describe the relation between pressure drop and apparent velocity for the grains listed, with only small deviations from observed values, throughout the range of the observations. It should be noted, however, that the data for ear corn, lot 2, does not conform to this equation. The tests on ear corn were made with different equipment and at an earlier time.

There was no experimental evidence to indicate the validity of this equation if extrapolated to values above or below the range of Shedd's data. It is interesting to note, however, that as the value V in equation [2] increases without limit the relationship between P and V approaches $P = kV^2$, and as V decreases towards zero the relationship approaches $P = kV$.

TABLE 1. CHECK ON FORMULA $\Delta P = a V^2/\log_e(1 + bV)$

(For grains represented in Shedd's data having values of ΔP over range of V from 2 to 40 fpm)

Grain	Value of a	Value of b	For V=40 Obs ΔP	For V=40 Comp ΔP	For V=10 Obs ΔP	For V=10 Comp ΔP	For V=2 Obs ΔP	For V=2 Comp ΔP
Fescue	.000276	.065	.34	.34	.053	.050	.0090	.0091
Soybeans	.000358	.092	.37	.37	.051	.055	.0084	.0085
Shelled corn	.00065	.156	.52	.52	.069	.070	.0095	.0095
Popcorn (yellow)	.000572	.092	.59	.59	.088	.088	.0133	.0136
Barley	.00069	.070	.83	.83	.130	.131	.0215	.022
Popcorn (white)	.00071	.062	.91	.91	.145	.148	.024	.0245
Oats	.00080	.074	.93	.93	.140	.145	.023	.0235
Sorghum	.00078	.049	1.15	1.15	.19	.197	.0335	.034
Lespedeza (Kobe)	.00065	.035	1.2	1.2	.22	.218	.0395	.041
Wheat	.00092	.050	1.35	1.35	.235	.226	.0395	.039
Fescue	.00187	.030	3.8	3.8	.72	.705	.130	.133
Lespedeza (Sericea)	.00167	.017	5.2	5.2	1.1	1.07	.20	.207

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*Numbers in parentheses refer to the appended bibliography.

†Shedd used Q, P, a and b instead of V, ΔP, c, and k, but for convenience the latter symbols will be used in this paper.

‡Note that logarithm to the base e, is used. $\text{Log}_e = 2.3 \log_{10}$ (approximately).

The representation of the data in equation form does not have much, if any, advantage in applying the data directly to design for parallel air flow. For this purpose the pressure drop for given air flow may be read directly off Shedd's chart which is a conveniently usable way of representing the data. On the other hand, when it is necessary to consider radial or non-linear flow and compute pressure drops, the algebraic expression can be handled more simply and accurately than the graphic representation.

For example, consider the case of radial flow, from a central cylindrical duct in a cylindrical perforated container in which the air moves in straight lines but the velocity is constantly decreasing from the perforated duct to the perforated container wall. The problem is to use Shedd's data to compute the pressure required to supply a given volume rate of air flow.

The following quantities are involved:

Q=rate of air supply, cubic feet per minute per foot length of cylinder

P=air pressure at any point in the grain, inches water

V=apparent velocity at any point, cubic feet per minute per square foot

S=distance from center of cylinder

R_1=radius of duct

R_2=radius of container.

The pressure drop per foot of grain described as ΔP can be written dP/dS so that from equation [2]

$$\frac{dP}{dS} = \frac{a V^2}{\log_e (1 + bV)} \quad . \quad . \quad . \quad [3]$$

In this bin the apparent velocity, V, at any point is

$$V = \frac{Q}{2 \pi S} \quad . \quad . \quad . \quad . \quad [4]$$

To get the rate of pressure drop for any point in the grain, substitute $Q/2\pi S$ for V in equation [3], giving

$$\frac{dP}{dS} = \frac{a Q^2}{4\pi^2 S^2 \log_e (1 + \frac{bQ}{2\pi S})} \quad . \quad . \quad [5]$$

TABLE 2. TABLE FOR COMPUTING PRESSURES IN RADIAL FLOW

$Q = 200 \quad b = 0.156 \quad aQ/2\pi b = 0.132$

S (ft)	$\frac{bQ}{S}$	$f(\frac{bQ}{S})$*	$\frac{aQ}{2\pi b} f(\frac{bQ}{S})$	P*
0.5	62.4	6.00	.79	.81
1	31.2	3.61	.48	.50
2	15.6	1.99	.26	.28
3	10.4	1.27	.17	.19
4	7.8	.78	.103	.128
5	6.2	.42	.055	.080
6	5.2	.19	.025	.050
7	4.46	-.01	-.001	.024
8	3.9	-.19	-.025	0

*f(bQ/S) is read from Fig. 1 and P is the computed pressure at various distances from the center.

This can be integrated to give the pressure at any point in the bin,

$$P = \int \frac{a Q^2 \, dS}{4\pi^2 S^2 \log_e (1 + \frac{bQ}{2\pi S})} = \left[\frac{aQ}{2\pi b}\right] \left[\log_e \left(\log_e (1 + \frac{bQ}{2\pi S})\right) + \log_e (1 + \frac{bQ}{2\pi S}) + \frac{\log_e^2 (1 + \frac{bQ}{2\pi S})}{2 \times 2!} + \frac{\log_e^3 (1 + \frac{bQ}{2\pi S})}{3 \times 3!} \text{-------}\right] + C$$

. . . . . [6]

Since the infinite series part of equation [6] is laborious to solve for each value of b, Q and S, the solution can be handled most readily by computing, once for all, the value of the series for various values of bQ/S. Fig. 1 shows the value of the series

$$f(\frac{bQ}{S}) = \log_e \left[\log_e (1 + \frac{bQ}{2\pi S})\right] + \log_e (1 + \frac{bQ}{2\pi S}) + \frac{\log_e^2 (1 + \frac{bQ}{2\pi S})}{2 \times 2!} + \frac{\log_e^3 (1 + \frac{bQ}{2\pi S})}{3 \times 3!} \text{----}$$

. . . . . [7]

for a range of bQ/S. With this chart it is rather simple to compute the pressure difference between any two points, for example, between $S=R_1$, the radius of the duct, and $S=R_2$, the radius of the cylindrical container. The computation may be made as follows:

Shelled corn in a cylindrical bin 16 ft in diameter is ventilated by passing air outward from a central duct 1 ft in diameter. The flow is 200 cfm per ft of duct length. The duct and bin wall are perforated to give negligible pressure drop through the duct and wall material.

The constants a and b from Shedd's data for shelled corn have the following values: $a=0.00065$; $b=0.156$

The pressure at the duct surface, $R=0.5$ ft, and at each successive foot radius may be found by making a tabulation similar to Table 2. This computation can be made for any values of Q, S, a and b, and so can be applied to any cylindrical bin with a cylindrical duct in the center and for any grain for which the constants a and b are known.

The pressure *differences* for radial flow in shelled corn have been computed and are shown in Fig. 2. It should be noted that Q is the volume of air per foot of length of a full round cylinder. If a half cylindrical duct were to be used on the floor and the flow confined to 180 deg of arc, for exam-

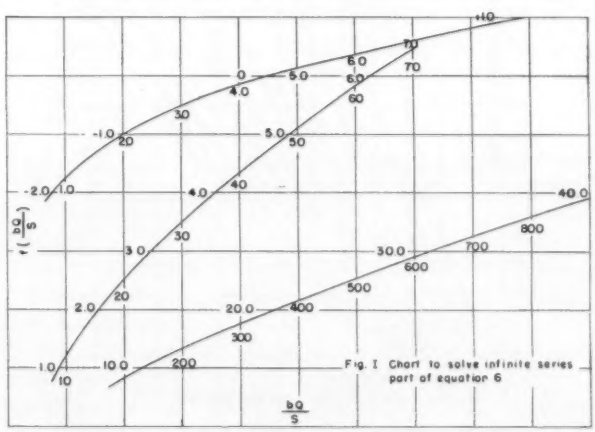

Fig. 1 Chart to solve infinite series part of equation [6]

ple, then the Q used to enter the chart is twice the actual flow in cubic feet per minute per foot of length.

To read from Fig. 2 the pressure required to force 250 cfm per ft of length through shelled corn in a half cylindrical pile 16 ft across and 8 ft high (radius=8 ft) having a half cylindrical duct 1 ft in diameter on the floor at the center of the pile, proceed as follows: 250 cfm per ft of length in the half cylinder is equivalent to 500 cfm in a full cylinder, Q=500 cfm per ft of length. Enter the chart of Fig. 2 at Q=500 and R=0.5. Read P=3.64 in. Enter at Q =500 and R=8. Read P=0.37 in. (3.64—0.37=3.27) which is the pressure required. The same procedure applies whether the air is forced from the duct outward or drawn inward to the duct. The pressure at any other point in the corn can be computed similarly.

TABLE 3. COMPARISON OF OBSERVED TO COMPUTED DIFFERENTIAL PRESSURES, INCHES WATER GAGE, IN SHELLED CORN FOR A RADIAL FLOW SYSTEM

(6-in duct radius, 8-ft grain radius, apparent entering air velocity, 183 fpm)

	Pressure difference, inches of water								
Increment radial depth, ft	0.5-1.0	1-1.5	1.5-2	2-3	3-4	4-5	5-6	6-7	7-8
Average observed values, P_o	2.06	.67	0.41	.50	.31	.21	.156	.118	.086
Average computed values, P_c	1.73	.72	.43	.47	.26	.205	.145	.116	.076
Ratio (P_o/P_c)x 100	119	93	95	106	119	102	108	102	113

Experimental

To study divergent flow patterns in grain, a special pressure-testing bin and air-flow apparatus was constructed as shown in Fig. 3. This equipment consists essentially of a full scale model of the smallest complete element of any air duct distribution system in a grain bin. The structure containing the grain measures 8 ft x 8 ft x 18 in, which dimensions represent, respectively, one-half the width of a single central duct system (or one-half the duct spacing in a multiple-duct system), bin depth, and the length of bin parallel to the duct. Air pressure was supplied by a small centrifugal fan and air flow was measured by use of a calibrated perforated steel sheet (3) installed in the air entrance plenum as shown at D-D′. Quarter-circle ducts covered with fly-screen wire were installed in the lower left-hand corner as shown at A-A′ (6-in radius) and at B-B′ (24-in radius). For radial flow studies the outer grain surface was formed by a screened cover C′C″. Thus with the 6-in duct installed, a circular segment of grain was contained by two concentric screened surfaces which provided for radial flow, the air entering the grain at surface A-A′ and leaving the grain at surface C-C″.

Pressure tap holes of approximately 1 mm diameter were drilled through one of the 8 x 8-ft walls. These holes were located to conform to a radial grid pattern as shown in Fig. 3. Static pressure at each hole was determined by use of an inclined-tube manometer reading to plus or minus 0.01-in accuracy and a micromanometer (4) which gave consistent readings to within ±0.001 in water gage. The higher pressures were taken with the former, and those equal nearly to that of the atmosphere, such as at radius distances of 6 and 7 ft, were read with the micromanometer. To take a pressure reading, connection was made with a pressure tap hole simply by pressing the end of the rubber tubing against the wall around the hole. These holes were made airtight by filling them with hot wax and as the wax solidified puncturing a hole through the soft wax with a small wire. It was assumed, and later verified by use of a long, small bore hypodermic needle, that the pressure at the inner surface of the wall was the same as that at any corresponding point in the interior of the grain.

Shelled corn was used in the tests reported. It contained about 13 percent moisture and approximately 3½ percent of cracked kernels and chaff. To compare the air-resistance properties of this lot of corn with that used by Shedd (2), a

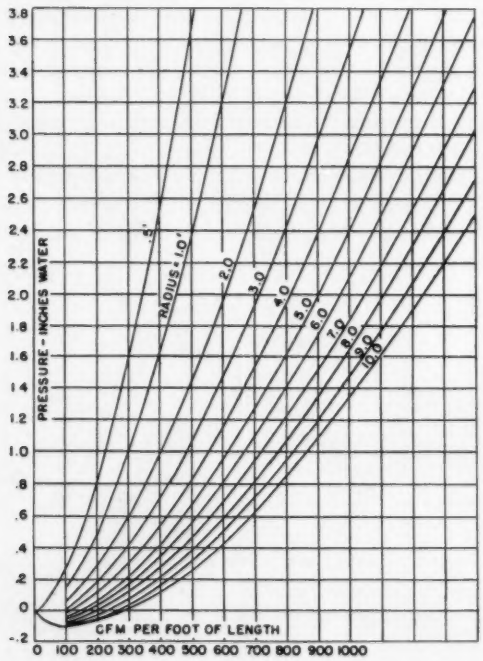

Fig. 2 Air pressures in shelled for radial air flow

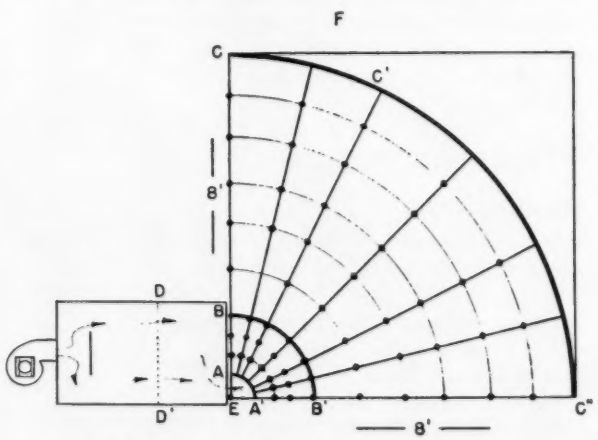

Fig. 3 Experimental apparatus to study divergent flow

screened floor was installed 6 in above the floor of the test bin. For a range of apparent velocities of 9.6 to 33.2 cfm per sq ft the observed plenum chamber pressures were from 5 to 8 percent greater than the corresponding values as read from Shedd's curve.

A series of radial flow tests was run with the 6-in and the 24-in ducts installed. The equipment employed provided a maximum air delivery of about 340 cfm when the 24-in duct was installed and about 220 cfm for the 6-in duct. Corresponding static pressures in the duct at these maximum delivery rates were approximately 2.8 and 4.6 in water gage, respectively.

Results and Discussion

Fig. 4 shows the pressure pattern as observed for one of the tests in which the corn was distributed uniformly as the bin was filled by use of a flexible downspout. The departure of the pressure contours from the concentric circular arcs is due presumably to the increased density of the corn near the bottom of the bin. Five flow lines were drawn perpendicular to the pressure contours graphically by use of a surface mirror, which show the departure of the actual flow lines from the theoretically radial flow pattern.

The validity of equation [6] was checked by comparing the observed pressure readings at the several points with those computed by the equation as well as comparing the corresponding differential pressures along each radial line for each increment of radial depth. Fig. 5 shows the corresponding observed and calculated pressures plotted graphically for a 6-in and 24-in duct test, and Table 3 compares the differential pressure for the 6-in duct test.

As evident in both Fig. 5 and Table 3, greatest departure of the observed from the calculated values generally occurred in that portion of grain near to the duct surface. The cause of this increase was not determined. It was shown that it did occur throughout the first few inches of grain away from the duct and therefore was not strictly a surface-entrance effect or an added resistance caused by the duct membrane, which was common fly screen in these tests. Furthermore, it was relatively as great at the lowest as at the highest entry velocities employed, which ranged from about 40 to 200 fpm. Closure of approximately 50 percent of the screened entrance area had no observable effect on the system resistance characteristics for entering velocities of less than 150 fpm. Reducing the percentage opening to 20 percent and below greatly restricted the air flow, especially at the higher entry velocities.

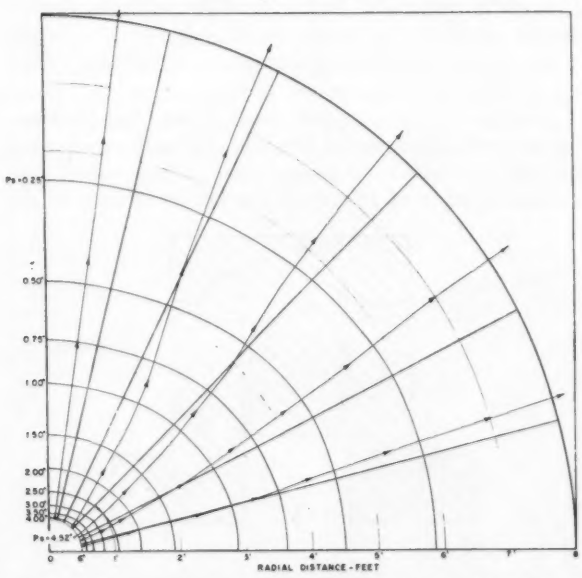

Fig. 4 Pressure pattern in test with radial air flow of 216 cfm

The difference between the experimental and computed plenum-chamber pressure was found to be equivalent approximately to the resistance of 0.1 ft of added grain depth at the duct for all tests employing both the 6-in and 24-in ducts. This suggests an empirical correction for design purposes of simply assuming the radius of the inner grain surface to be 0.1 ft less than the actual duct radius to be used.

It is of practical significance to note from either Fig. 4 or 5 that for the conditions of this test, three-fourths of the total pressure drop occurred in less than 5 percent of the total grain mass, or over three-fourths of the fan and motor capacity and energy was used to force the air through the first 5 percent of the grain.

Good engineering design will give due consideration to the overall effect of various duct sizes, spacings and arrangements on the total costs to install and operate the air distribution system.

Bibliography

1 Shedd, C. K. Some new data on resistance of grains to air flow. AGRICULTURAL ENGINEERING 32:9, September 1951.

2 Shedd, C. K. Resistance of grains and seeds to air flow. AGRICULTURAL ENGINEERING 34:9, September 1953.

3 Shedd, C. K. Measuring air flow with perforated metal sheet. AGRICULTURAL ENGINEERING 35:6, June 1954.

4 Shedd, C. K. A micromanometer. AGRICULTURAL ENGINEERING 34:3, March 1953.

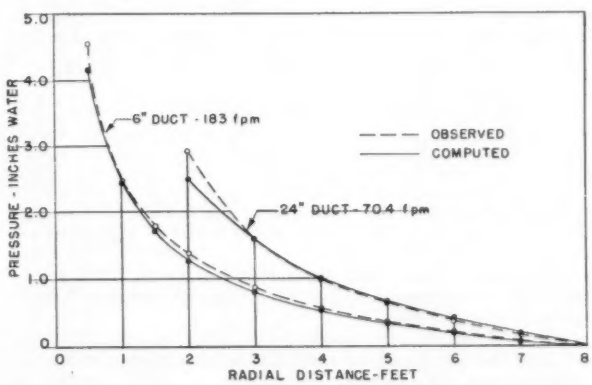

Fig. 5 Comparison of observed and computed pressures for radial air flow in shelled corn

Engineering Ethics

WHEN engineering employers habitually and regularly insist that engineers shall know their ethics, just as they insist that engineers shall be technically competent, they will have gone a long way toward giving engineers professional standing. Then, and not until then, will engineers enjoy the professional standings of physicians and lawyers in the employ of corporations.

Once the employer has given his engineers full professional standing, he can safely discard the countless rules and regulations of the familiar employees' handbook, as far as his engineers are concerned.

Efficiency of a Milk Homogenizer Valve

Ching Chee Loo
Assoc. Member ASAE

A report on experimental data taken in connection with a laboratory study of the efficiency of valves used in the homogenization of milk

HOMOGENIZATION of milk products has a history of more than 50 years. Its theory has not been very well understood. Several recently published articles relative to the mechanism of homogenization are listed in the appended bibliography for reference (1, 2, 3, 4, 5, 6, 7).* The bibliography is by no means complete, since it is not the aim of this paper to review the literature.

Homogenization, specifically, is an operation that tends to stabilize the suspension of milk fat in milk by reducing the size of fat globules. In some milk products, a higher viscosity, which helps stabilize the fat, might also be effected by homogenization. The homogenizing action is obtained most commonly by forcing the milk under high pressure through a relatively small opening. Acoustic waves have also been reported successful for homogenizing milk. However, we are concerned only with the continuous pressure homogenization in the discussion in this paper.

The homogenizing opening is usually manufactured in an adjustable form resembling that of a poppet valve. Some commercial makes are in the form of an aggregate of small elements such as wires or round shots. In an investigation carried out at the Carnation Company research laboratory, most of the homogenizing openings were in the form of fixed orifices. Some of them were round holes ranging from 0.006 to 0.023 in in diameter and 0.02 to 0.25 in in length. Some of them were just narrow slits ranging in width from 0.001 to 0.006 in. Some others were like the poppet valves but had the seats narrowed down to almost nothing. Though they may not look like valves any more, for the sake of convenience, they will all be referred to as homogenizer valves.

Using these various kinds of valves, some factors relative to the design and operation of a homogenizer valve were investigated. They were

- The type of flow
- The length of treatment time
- The dimensions of the valve
- The back pressure applied to a homogenizer valve.

By using orifices of fixed dimensions and a pump of adjustable capacity, it was possible to organize an experiment such that the effects, due to some of the various factors, could be individually evaluated for significance. Others require statistical methods to extract and evaluate them. The influence of a factor on the efficiency of a homogenizer valve was judged by its effect on the stability of the fat in the treated milk.

Some of the experimental results relative to the effect of the type of flow on valve efficiency are presented in Fig. 1. It is obvious from this graph that, if the flow of milk in the valve had a Reynolds number below 2000, only slight improvement of the stability of fat was obtained. This improvement in stability was independent of the Reynolds number. As the Reynolds number went over 2000, the homogenizing effect increased steadily. It is rather interesting that this particular Reynolds number of 2000 is about the dividing point between laminar flow and turbulent flow. This observation might help to settle the problem whether laminar shearing is an important factor of homogenization. It appears that good homogenization is accompanied by turbulent flow rather than laminar flow.

On the factor of time, our results showed that by allowing the milk more time in the valve, no gain in efficiency was obtained unless the pressure was also increased. The shortest duration of treatment was just as efficient as the

Paper presented at the annual meeting of the American Society of Agricultural Engineers at Minneapolis, Minn., June, 1954, on a program arranged by the Committee on Agricultural Processing. Part of the experimental data reported in this paper is taken from a thesis submitted by the author in partial fulfillment of the requirements for the PhD degree in agricultural engineering at Michigan State College.

The author—CHING CHEE LOO—is a senior staff member in charge of special products, Carnation Company Research Laboratories, Van Nuys, Calif.

Acknowledgment: The author expresses his thanks to Carnation Company for permission to publish part of the experimental results presented in this paper.

*Numbers in parentheses refer to the appended bibliography.

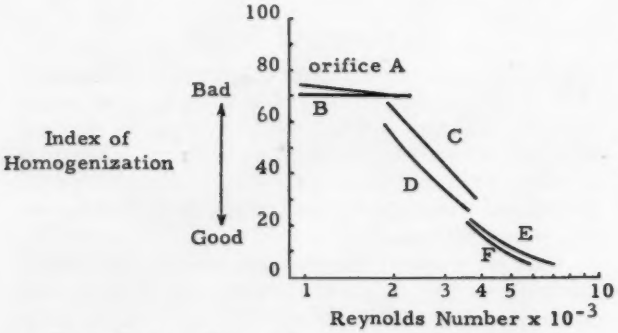

Fig. 1 Efficiency of homogenization versus Reynolds number

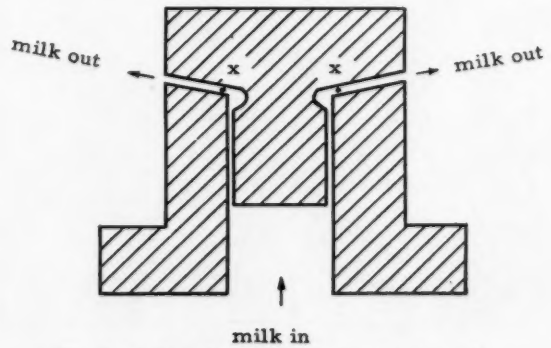

Fig. 2 Outline of a poppet-type homogenizer valve

longest treatment. The time range studied was from 0.55x 10^{-4} to 2.36x10^{-4} sec. We also noticed that increasing the length of the homogenizing passage (or the dimension of the valve opening in the direction of the flow) within the investigated range had a slightly unfavorable effect on the efficiency of a valve.

In our earlier work, we used round orifices of various sizes. We observed that smaller holes were more efficient, though other factors such as the degree of turbulence, the duration of treatment, and the applied pressure were the same. In order to investigate more fully this dimensional effect, a number of rectangular orifices having the same cross-sectional area but varying in the breadth to width ratio were constructed and tested for homogenization efficiency. By so doing, it was possible to separate the effect of the cross-sectional area from the effect of hydraulic radius (cross-sectional area divided by wetted perimeter) of an orifice. These rectangular orifices, although having the same cross-sectional area and practically the same pressure-to-capacity relationship, exhibited distinct differences in their efficiencies. The efficiency of the orifice increased as the hydraulic radius was decreased. This means that a high ratio of wetted perimeter to cross-sectional area favors homogenization action.

The next factor influencing the efficiency of a homogenizer valve to be discussed is the back pressure on a homogenizer valve. It was reported previously (3) that actual sampling of milk at different radial positions in a poppet-type valve showed that homogenization action should take place at a point inside the valve opening at a very short distance from the entrance to the opening. This location is illustrated by point X in the diagram of a common homogenizer valve in Fig. 2. Therefore, to study the effect of back pressure, valves that resembled the poppet-type valve, but had their seats narrowed down to substantially nothing so that the back pressure on the homogenizing region could be easily measured, were used. The results showed that a back pressure of 50 to 150 psi increased the efficiency of a valve. Fig. 3 shows a few representative curves of the relationship between back pressure and valve efficiency.

In a common poppet-type valve which has a relatively wider seat, the back pressure on the homogenizing region could be expected to be quite high because of the high frictional resistance beyond the homogenizing region. On the graph shown in Fig. 3, the operation of such a valve would be represented by a point at a considerable distance to the right of the optimum back pressure.

A homogenizer valve, shown in Fig. 4, was built to demonstrate the results of the present investigation. Its openings are rigidly fixed by spacers to obtain a hydraulic radius of less than 0.0005 in. The surfaces forming the homogenizing passage are about 0.01 in wide. The entrance to this passage is formed by corners of acute angles. Only 800 psi pressure is necessary for it to homogenize fresh whole milk as satisfactorily as conventional-type valves operating at 2000 to 3000 psi pressure. Of course the capacity and operational pressure of such a valve is fixed for a certain given product. Its clearances could only be adjusted to a limited extent without impairing its efficiency by changing the spacers. Two likely limitations of this valve may arise from the erosion of the valve and clumping of fat globules in high fat products. Investigations in these respects had been undertaken, although no such difficulties had been experienced to date.

SUMMARY

1 The homogenization efficiency of a valve begins to increase with the Reynolds number only when the latter is over 2000.

2 A longer time spent by the milk in a homogenizer valve does not seem to increase the efficiency of the valve.

3 Smaller hydraulic radius of the homogenizing opening produces better homogenization.

4 A back pressure of 50 to 150 psi applied to the homogenizing region is most desirable.

BIBLIOGRAPHY

1 Kremnev, L. Ya. & Kuprik, V. S. Homogenization of emulsions by passing through capillaries under low pressures. Doklady Akad, Nauk S.S.S.R., vol. 80: 623-5, 1951. (Cited in *Chemical Abtracts* vol. 46: 1331 C, 1952).

2 Loo, C. C., & Slatter, W. L., & Powell, R. W. A study of the cavitation effect in the homogenization of dairy products. *Journal of Dairy Science,* vol. 33: 692-702, 1950.

3 Loo, C. C., & Carleton, W. M. Further studies of cavitation in the homogenization of dairy products. *Journal of Dairy Science,* vol. 36 (1): 64-75, 1953.

4 Schulz, Von W. Die Beeinflussung des Homogenisierungseffektes durch die Art und Anordnung des Homogenisierspaltes. Milchwissenshaft, Jahrg. 5 Heft 10: 349-353, 1950.

5 Schulz, Von W. Vergleiche iiber den Homogenizierеeffekt bei mehrstufigem und einstufigem Druckabfall in Homogenisierkopf. Milchwissenshaft, Jahrg. 6 Heft 12: 429-431, 1951.

6 Wittig, A. B. Homogenization of milk for human consumption. Proceedings XII International Dairy Congress, vol. III: 118-128, 1949.

7 Wittig, A. B. The homogenization process, its rise, progress, and effects. Proceedings XIII International Dairy Congress, vol. II: 386-393, 1953.

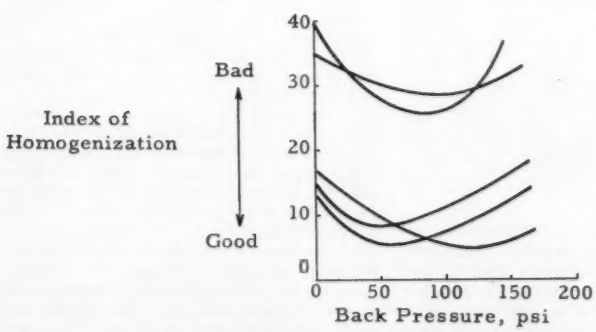

Fig. 3 Efficiency versus back pressure of a sharp-edged homogenizer valve

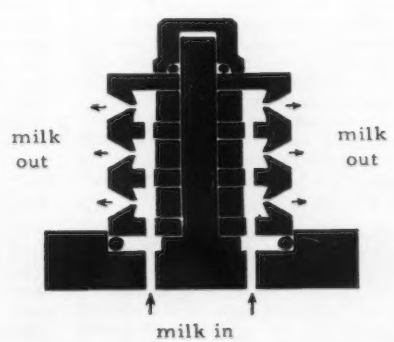

Fig. 4 Outline of a multiopening sharp-edged homogenizer valve

RESEARCH NOTES

Brief news notes and reports on research activities of special agricultural-engineering interest are invited for publication under this heading. These may include announcements of new projects, concise progress reports giving new and timely data, etc. Address: Editor, AGRICULTURAL ENGINEERING, St. Joseph, Michigan.

USDA Research Activities

Louisiana Sugar-cane Planter. R. M. Ramp, USDA Farm Machinery Section engineer in charge of sugar-cane machinery research at Houma, La., reported last month to the American Society of Sugar Cane Technologists on a 4-wheel tractor-powered sugar-cane planter developed under USDA sugar-cane machinery project and that is adapted to Louisiana conditions. The machine was designed to meet requirements as recommended by the Sugar-cane Farm Machinery Research Advisory Committee. It opens a planting furrow to desired depth and width, handles full-length canes to be cut in half or 36-in lengths, covers the cane, holds 2 to 2½ tons of seed cane, may be adjusted for planting rates of two or three lines, and is designed so that seed cane can be supplied to the planter by the conventional method.

Experimental use showed that the mechanical planter provides more uniform control of depth and coverage than ordinary methods provide; that more uniform placement of the seed cane is possible, and time is saved by making one operation of opening a furrow, planting, and covering.

Time and Travel Studies. USDA Farm Buildings Section engineers are continuing time and travel studies relative to dairy farm chores and dry-lot feeding of beef cattle, in cooperation with the Illinois Agricultural Experiment Station at Urbana. Harry Garver, of the Farm Buildings Section at Beltsville, Md., reports considerable interest in these studies. Time and travel studies in connection with poultry are being considered.

Thayer Cleaver, Farm Buildings Section engineer in charge of this research work at Urbana, recently conducted time and travel studies relative to hog production in California and the effect of building layouts on time required to do dairy chores in Massachusetts.

Farm Poultry Dressing Plants. Labor-saving techniques for farm poultry dressing plants provide one of the goals of cooperative research between the Agricultural Engineering Research Branch and the Poultry Husbandry Research Branch of the USDA Agricultural Research Service. Engineers of the USDA Agricultural Research Service. Engineers of the Mechanical Preparation and Conditioning Section are setting up a small-scale farm-type poultry dressing plant for experimental use at the USDA Agricultural Research Center at Beltsville, Md. The plant will feature simplicity of operation, labor-saving devices, minimum equipment, and adequate sanitation. Its purpose is to provide a model of the type of farm plant that could be used to advantage by those producers who market at least a part of their poultry direct to consumers.

Aluminum Farmhouse. H. J. Thompson and Archie Biggs of the Farm Buildings Section in cooperation with L. E. Campbell and C. P. Davis of the Farm Electrification Section, are beginning tests of the thermal characteristics of an experimental aluminum farmhouse located at the Agricultural Research Center. Equipment has been installed for the testing which will include determination of the efficiency of a heat pump for heating and cooling the house.

Lights to Aid Turkey Production Engineers of the Farm Electrification Section at Beltsville, Md., are cooperating with poultry scientists in an effort to lengthen the normal season of egg production by turkeys by the use of lights. The engineers have provided the lighting equipment and instruments for light measurement used in connection with the project.

Advisory Committee Meets. Ten high-priority recommendations were made by the Farm and Home Equipment and Structures Research Advisory Committee which met in Washington, D. C., March 7-9, to discuss research efforts being conducted by the Agricultural Engineering Research Branch, the Soil and Water Conservation Branch, Home Economics Branch of the Agricultural Research Service, and the Forest Service.

The 11-member committee, the first advisory body to deal with USDA research in agricultural engineering and allied fields, was appointed last October by Secretary of Agriculture Ezra Taft Benson, to advise on research efforts intended to provide better homes, buildings, machinery and equipment for farm families.

Priority recommendations made by the committee at its initial meeting called for farm machinery research to develop equipment to control soil-borne organisms, a weed-free combine, and machines and methods for the placement of fertilizer. The committee asked for research on irrigation and drainage to determine the factors affecting selection of irrigation distribution systems, and in farm electrification to study the role of electricity in farm mechanization. In research on farm structures, housing and related equipment, the committee recommended expansion to include the farmstead as a whole. They also recommended study of grain and seed drying in relation to other farm practices, of farm water supplies, plumbing, and farm home heating, cooling and ventilating. In addition, the committee recommended research for controls for regulating movement and condition of cotton through ginning operations and in poultry preparation for farm or roadside stand sales. More than 80 recommendations were made by the committee, covering fields of effort in the three ARS branches and the Forest Service.

Members of the committee, chosen among agricultural and industrial leaders are: Stanley M. Madill, Deere & Co., and W. G. Kaiser, both former presidents of the ASAE; F. Earl Price, dean of agriculture, Oregon State College, and W. D. Hemker, Westinghouse Electric Corp., both ASAE members; Dale Erlewine, Grant, Neb., wheat farmer, H. Rogers Hamilton, Okanogan, Wash., fruit grower, Mrs. Elizabeth S. Herbert, McCall's Magazine, New York, B. R. Hurt, Dunlap, Ill., hog and dairy farmer, Mrs. Evelyn B. Owens, Dousman, Wis., J. C. Portis, Lepanto, Ark., cotton farmer, and A. L. Vandergriff, Lummus Cotton Gin Co., Columbus, Ga. Executive secretary of the committee is Dr. Carleton P. Barnes of the ARS, USDA.

Crop Drying Research. Wallace Ashby, head of Farm Buildings Section of the Agricultural Engineering Research Branch, and W. V. Hukill of FBS, stationed at Iowa State College, consulted in April with agricultural leaders on peanut-curing and corn-drying research at Holland, Va., and on grain and seed drying work at Athens, Ga.

Public Patent Granted. John G. Taylor, AERB Farm Electrification Section, Purdue, Ind., was awarded a public patent in April on his proportional time and temperature controller for infraread chick brooders. The device permits automatic control of the infrared lamps used in the brooders, thus retarding or shutting off the lamps according to the control setting and adding to the safety factor in the use of such brooders.

Mr. Taylor took part in a seminar held last month in the agricultural engineering building at Purdue University, at which brooder manufacturers were given the latest information on brooder design from federal, state and industry researchers. Other staff members of the USDA, Purdue University agricultural engineering department and the poultry science department took part in the seminar.

Improved design of the brooders was discussed at the meeting along with new lamps, especially designed for the purpose, the need for safety devices and the use of plastic and aluminum curtains for the brooders. The new thermostatic controller also was discussed.

Poultrymen and power company representatives attended the meeting to hear discussions of some of the problems in connection with the use of infrared brooders.

Ginning Laboratory for Southeast Region. The 1955-56 ginning season will see research operations underway in USDA's new Southeastern Cotton Ginning Research Laboratory now under construction at Clemson, S. C. James A. Luscombe, of AERB's Mechanical Preparation and Conditioning Section, has been named agricultural engineer in charge of engineering research at the new laboratory. Formerly Mr. Luscombe headed up this work at the state-federal ginning laboratory at Chickasha, Okla. The experimental work in ginning at the new laboratory will be under overall supervision of Charles A. Bennett, of the MPCS, who also supervises ginning investigations at Stoneville, Miss., Mesilla Park, N. M., and Chickasha.

Staff members selected so far to assist Mr. Luscombe at Clemson, include W. E. Garner recently of the agricultural engineering department at the University of Georgia, and J. B. Coche of the Belle Glade, Fla., long-vegetable fiber-crop laboratory of MPCS.

The engineering staff will cooperate closely with the agricultural engineering department of the Clemson College Agricultural Experiment Station on ginning research as it applies to production of cotton. The engineers will also cooperate with the Agricultural Marketing Service and the Clemson Textile School and industry on fiber quality evaluation.

New Cotton Seedbed. A new idea for a cotton seedbed, developed by federal-state agricultural engineering research at the Oklahoma Agricultural Experiment Station, has proved materially more efficient under test than older types of seedbeds.

E. M. Smith of AERB'S farm machinery section and Jay G. Porterfield of the Oklahoma A&M department of agricultural engineering, have reported on the new plan, and the modified planter used to make the seedbed, in a bulletin issued recently by the College. The Oklahoma bulletin, No. B-449; entitled "Development and Test Performance of a New Seedbed for Cotton," presents details of the machine and method used in preparation and cites field tests made the past year under which its improvement over conventional seedbeds is clearly established.

Graduate Theses in Agricultural Engineering

[EDITOR'S NOTE: This list includes theses dated September 1953 and later submitted in partial fulfillment of advanced degrees at colleges and universities. Listing includes in the order given: *(a)* title, *(b)* author, *(c)* date accepted, *(d)* citation if published, and *(e)* place where available for reference use.]

University of Georgia, Athens

Vegetative Material Distribution and Durability in the Soil Profile as Influenced by Methods of Tillage, James H. Turner, June 1954. Available at agricultural engineering department.

A Comparison of One-Way and Two-Way Air Flow Methods of Drying High-Moisture Corn, Lloyd L. Smith, June 1954. Available at agricultural engineering department.

University of Idaho, Moscow

Some Mechanical Devices for Handling Livestock Feeds, Eugene S. Craig, May 1954. Available at University library.

University of Illinois, Urbana

Flexural Properties of Corrugated Metal Roofing, Howard L. Wakeland, August 1954. Available at University library.

Purdue University, Lafayette, Indiana

Some of the Component Power Requirements of Field-Type Forage Harvesters, Frederick Z. Blevins, May 1954. Available at University library.

Heat Required to Vaporize Moisture in Wheat and Shelled Corn, Howard K. Johnson, May 1954; AGRICULTURAL ENGINEERING, October 1954. Available at University library.

Analysis of Functional Requirements for Drying Hay, Charles M. Milne, May 1954. Available at University library.

Pressure in Grain Bins Resulting from Increases in Moisture, Robert N. Robinson, January 1954; AGRICULTURAL ENGINEERING, August 1954. Available at University library.

Iowa State College, Ames

Development and Performance of a Corncob Processing Machine, Darwin C. Bichel, 1953; AGRICULTURAL ENGINEERING, July 1954. Available at College library.

Comparison of Corn Harvesting Methods, Floyd L. Herum, 1954; Iowa Farm Science 8(1):7-8, 1954. Available at College library.

Vinyl Paint for Protection Against Corrosion from Agricultural Chemicals, Israel Nachmany, 1954. Available at College library.

Instrumentation of a Mounted Implement Dynamometer, Donnell R. Hunt, 1954. Available at College library.

Ridge Farming and Plant Root Environment, Wesley F. Buchele, 1954; AGRICULTURAL ENGINEERING, May 1955. Available at College library.

Analysis and Development for the Application of Hydraulic Power to a Sequence of Movements in an Experimental Ditching Machine, William C. Eaton, 1954. Available at College library.

Secondary Stresses in Trusses with Rigid Joints, Special Application to Glued Wooden Trusses, James S. Boyd, 1954. Available at College library.

Wind-Resistant Characteristics of and a Standard Rating Procedure for Asphalt Shingles, Sydner H. Byrne, 1954. Available at College library.

Analysis of Factors Affecting the Strength of Glued Gusset Plates for Timber Frames, Donald G. Jedele, 1954. Available at College library.

Analytical and Empirical Evaluation of Water Table Behavior as Affected by Drainage Systems, Jan van Schilfgaarde, 1954; AGRICULTURAL ENGINEERING 35:474-478, 1954. Available at College library.

Water Table Shape and Flow Nets at the Upper End of Subsurface Drains, Ross W. Irwin, 1954. Available at College library.

Kansas State College, Manhattan

The Adaptability of the Heat Pump to the Batch Drying of Shelled Corn, Gene C. Shove, September 1953. Available at College library.

A Study to Determine the Cost of Sprinkler Irrigation in Kansas, Russell L. Herpich, September 1953. Available at College library.

Mechanical Tripping of Alfalfa Flowers, Milton L. Keim, September 1954. Available at College library.

Aeration Techniques for Stored Wheat, Juanito L. Ordoveza, September 1954. Available College library.

University of Maine, Orono

Design and Development of a Side-Delivery Stone Picker, Rodney O. Martin, June 1954. Available at agricultural engineering department.

Design and Development of a Low-Cost Portable Potato Conveyor, Herbert J. Hurme, June 1954. Available at agricultural engineering department.

Michigan State University, East Lansing

Silage Removal from the Horizontal Silo, Nathan Rich, 1953. Available at University library.

Indonesian Agriculture: Its Agricultural Engineering Applications and Problems, Robert L. Green, 1953. Available at University library.

Drying White Pea Beans with Heated Air, Robert L. Maddex, 1953. Available at University library.

Electric and Inertial Forces in Pesticide Application, Henry Bowen, 1953. Available at University library.

Mechanization of Agriculture in Iran, Nuri Mohsenin, 1953. Available at University library.

Some Effects of Chromatic Illumination, Reflectance, and Product Rotation on Sorting Efficiency of Cherries and Tomatoes, Blaine Parker, 1954; AGRICULTURAL ENGINEERING, February 1955. Available at University library.

Design and Performance of Fan Ventilation in Poultry Laying Houses, Jacques Choiniere, 1953. Available at University library.

Development of New Methods to Determine the Relationships Between the Draft Requirement and the Fundamental Factors Affecting the Draft Requirement of Tillage Tools, Baba Telischi, 1954. Available at University library.

The Design of Simplified Equipment for the Rapid Determination of the Moisture Content of Grain and Forage Crops, Gerald Isaacs, 1954. Available at University library.

Indent Removal and Evaluation in Aluminum Sprinkler Irrigation Tubing, Dale Kirk, 1954; AGRICULTURAL ENGINEERING, December 1954. Available at University library.

Hot Water Usage for Dairy Farm Purposes, Warren Church, 1954. Available at University library.

Protection of Garden Crops Against Frost Damage by the Use of Overhead Irrigation, Walter Bilanski, 1954. Available at University library.

Growth Experiments on Young Chickens Exposed to High-Frequency Electrical Treatment, Drayton Kinard, 1954; AGRICULTURAL ENGINEERING, December 1954. Available at University library.

Weed Control by Mechanical Energy as a Pre-Emergency Soil Treatment, John B. Liljedahl, 1954. Available at University library.

The Use of Double-Pane Windows for Utilizing Solar Energy in Swine Housing, Maurice Brandt, 1954. Available at University library.

Effect of Plant Surfaces on Dust Deposition, Robert W. Brittain, 1954. Available at University library.

University of Minnesota, Minneapolis

Design and Construction of a Device for Filling Deep-Potato Storage Bins, James R. Beebe, 1954. Available at University library.

University of Missouri, Columbia

An Experimental Study of Filter Design for Treatment of Pond Water for Domestic Use, Buford E. Guyer, June 1954. Available at University library.

University of Nebraska, Lincoln

Torque Characteristics of Tractor Engines and Tractor Performances, Shih-Chien Kao, July 1953. Available at University library.

The Effect of Length of Run and Size of Stream on Moisture Distribution Pattern in Irrigated Corn Furrows, Billie B. Bryan, April 1954. Available at University library.

Calculating Irrigation Requirements Using Weather Data, George E. Williams, January 1954. Available at University library.

Drying Grain with Unheated Forced Air, George M. Petersen, January 1954. Available at University library.

Cornell University, Ithaca, N. Y.

A Study of the Draining Capacities of Longitudinal and Transverse Tile Drainage, Herman Bouwer, February 1955; AGRICULTURAL ENGINEERING, May 1955. Available at University agricultural library.

An Introduction to the Lateral Dynamic Stability of Towed Four-Wheel Vehicles with a Proposal of Simulators for its Investigation, Albert G. Fonda, February 1954. Available at University agricultural library.

Some Factors Affecting Irrigation Sprinkler Rotations Rate and Rotations Rate Effect on Water Distribution, Gene T. Gober, June 1954. Available at University agricultural library.

An Analysis of Methods of Grading Cut Flowers by Weight, Arthur D. Leach, Jr., February 1955. Available at University agricultural library.

Some Engineering Factors Involved When Laying Hens are Kept in Low-Ceilinged Pens, Frederick P. Stephan, February 1955. Available at University agricultural library.

Consumptive Use of Water Study in Pasture Irrigation, Benigno Lim, September 1953. Available at agricultural engineering department.

A Study of the Problem of Determining Pressures in Small Feed Bins, Walter Grub, September 1953. Available at University agricultural library.

A Study of Power Consumption of Forage Harvesters by Means of Calibrated Tractors

and Auxiliary Engines, David H. Huntington, September 1953. Available at University agricultural library.

The Milking of Cows—A Methods Study, Wilford H. M. Morris, September 1953; AGRICULTURAL ENGINEERING (in press), 1955. Available at University agricultural library.

Equipment for the Reduction of Dairy Chore Labor, Donald W. Richter, September 1953. Available at University agricultural library.

Ohio State University, Columbus

A Study of Tile Flow in Farm Drainage, Truman Goins, March 1954. Available at University library.

A Study of Wheat Harvesting Equipment and the Harvesting Characteristics of Wheat Varieties, William H. Johnson, June 1953. Available at University library.

Analytical Investigation of Rack and Straw Motions in Harvester-Threshers, Paul T. Yarrington, August 1954. Available at University library.

A Study of Possible Methods of Handling Grain Samples for Dielectric Moisture Tests, James Hartsock, August 1954. Available at University library.

Oklahoma A. & M. College, Stillwater

A Study of an Infrared Oven for Drying Soils Samples, Wilbur O. Mack, August 1954. Available at College library or agricultural engineering department.

Ontario Agricultural College, Guelph

The Permeability Characteristics of Some Heavy Clay Soils as a Basis for Drainage Design, D. M. Gray, May 1954. Available at agricultural engineering department library.

Development and Investigations of a Power-Operated Silage Cart, Lawrence A. Donoghue, May 1954. Available at agricultural engineering department library.

Application and Retention of Aqueous and Anhydrous Ammonia, John F. Mahoney, May 1954. Available at agricultural engineering department library.

North Carolina State College, Raleigh

The Design and Development of a Gravity-Flow Unit for Metering Liquid Nitrogen Solutions, James H. Anderson, November 1954. Available at College library.

North Dakota Agricultural College, Fargo

A Method of Determining Water Use, Soil Loss, Intake Rate and Length of Furrow for the Irrigated Lower Souris Basin, Willis H. Sletten, March 1954. Available at College library.

A. & M. College of Texas, College Station

A Study of Typical Farm Service Buildings to Determine Panel Sizes and Loadings in Current Use, William S. Blair, May 1954. Available at College library.

A Study of the Application of Sprinkler Irrigation to Cotton Production in the Brazos River Valley, Simon T. Russell, August 1954. Available at College library.

Comparison of the Blaney-Criddle Method of Determining the Consumptive Use of Water with Actual Measurements, Tommy L. Mixon, January 1954. Available at College library.

Virginia Polytechnic Institute, Blacksburg

An Analysis of Winter, Ventilation for Poultry Laying Houses, Blaine F. Parker, September 1952. Available at Institute library and agricultural engineering department.

Design Factors and Operational Requirements for Irrigating Burley Tobacco, James N. Jones, Jr., June 1954. Available at Institute library and agricultural engineering department.

A Farm Implement Torquemeter, John K. Hale, September 1954. Available at Institute library and agricultural engineering department..

University of Wisconsin, Madison

Cotton Growing Machines, M. H. Panhwar, 1953. Available at University library.

Draft Studies of Side-Hitched Implements, A. J. Wojta, 1954. Available at University library.

Last Call for Extension Exhibits

EARLY indications promise a new high in extension exhibits at the 1955 ASAE annual meeting at Urbana, Ill., June 12-15.

Announcement of Extension Committee plans for the exhibit, and a call for exhibit entries went out to a list of extension men in industry and public service in April. However, the list was not complete and others interested in submitting entires are invited to do so. Entry forms are to be mailed to Subcommittee chairmen before June 1.

Exhibit classes will include motion pictures, publications (bulletins and periodicals), slides and film strips, demonstration models, new text books, extension methods, and radio and television material. The subject matter may be in any of the four technical division fields, farm structures, power and machinery, rural electric and soil and water.

The exhibits are to be displayed in the general lounge on the second floor of the Illini Union, and also in hallways of the first and second floor, throughout the four days of the meeting.

Blue ribbon awards will be made for exhibits judged best in each class. The Committee has asked for simple exhibits of daily working material used to put across ideas and information, rather than for loud, flashy, expensive exhibits.

Movies prepared by commercial organizations and those prepared by public service agencies will be judged as separate classes. In addition to the ribbon award for each class a leader is awarded which can be attached to the film to indicate that it is an "ASAE Blue Ribbon Award" film.

Publications entries of both bulletins and periodicals will be divided into industrial and public angency classes, with any one person limited to one bulletin entry and/or one periodical entry. The periodical classification will include news letters and other educational publications issued at intervals.

A special "Method Outline" form has been drawn up for use in the "Extension Method" exhibits. Copies may be obtained from ASAE Headquarters.

Radio and television program material exhibits are also to be entered on special forms which are available from Don Brown, Agricultural Engineering Department, Michigan State College, East Lansing, Mich.

Difficulties in judging new textbooks may prevent the awarding of blue ribbons in that class, but entires are invited as of major interest in the exhibit.

Slides and film strips will also be judged in separate public agency and industrial classifications. In the case of demonstration models the classes are indicated as public agency and industrial or commercial. For the purposes of this exhibit the Committee especially invites entry of small, portable models which can be packed and carried in the trunk of an auto.

Model exhibits are to "show developments having engineering implications relating to agriculture. The primary objective should be the education of the viewer." They should be in good taste, and talk concerning them by exhibitors or their representatives in the exhibit area should deal with facts. Promotion literature of a technical or semi-technical nature may be displayed with a model or separately, and may be accompanied by blank forms to make it easy for viewers to write for further information. Selling, order taking, or sales promotion in or near the exhibit space is prohibited, and the Committee reserves the right to remove exhibits of any violators. Exhibitors must assume responsibility for providing adequate safety measures in connection with their exhibits, including protection of viewers from moving parts.

Exhibits to be shipped in should be addressed to the Illini Union Building, University of Illinois, Urbana, Illinois, and marked "ASAE Convention."

Each exhibitor will be responsible for the setting up, handling and removal of his or its exhibits. Exhibits are to be in place by 2:00 p.m. Sunday afternoon, June 12, and removed as soon as possible after 4:00 p.m. Wednesday, June 15. Exhibits may not be fastened to the floor or walls. Each must be self-supporting and set on floor, table or display stand. Convenience outlets for 110-volt current are available.

Requests for further information on arranging exhibits may be addressed to C. A. Kincaid, Portland Cement Association, 510 South Michigan Ave., Champaign, Ill.

C. V. Phagan is chairman and H. S. Pringle vice-chairman of the Committee on Extension which sponsors the exhibits. Subcommittee chairmen and members are (1) Movies—B. P. Hess, chairman, D. L. Maxwell, J. L. Calhoun, J. L. McKitrick, R. R. Parks; (2) Slides and film strips—E. A. Olson, chairman, I. P. Blauser, G. O. Schwab, John C. Campbell; (3) Publications—Arnold Nicholson, chairman, W. S. Allen, J. M. Ferguson, H. E. Stover, R. T. Scott; (4) Demonstration Models—F. W. Andrew, chairman, C. N. Hinkle; (5) Textbooks—J. P. Schaenzer; (6) Extension Models—R. L. Ricketts, chairman, J. C. Oglesbee, Jr.; (7) Radio and Television—D. P. Brown, chairman, D. O. Hull, R. R. Parks.

MSU Ag Engineers Have Cathode-Ray Machine

THE agricultural engineering department of Michigan State University announces that it has arranged to lease a one million-volt cathode-ray machine from General Electric Company. Installed last month in the agricultural engineering building, it is the only one of its kind in any agricultural experiment station.

The machine will be used for research in connection with cold sterilization of agricultural materials such as grain, milk, fruit and the like. It also has possibilities for use in developing new varieties of crops, since it has the power to change the chromosome arrangement in seeds. The machine will be available for the use of the agricultural engineering research staff, including graduate assistants. It will be used for the development of many important new basic research projects in the field of food preservation.

Organizational Strength of ASAE

(EDITOR'S NOTE: This report was compiled by Ralph A. Palmer, assistant secretary, at the direction of the Council of ASAE, as a matter of general interest to Society members.)

ENGINEERING appreciation of quantitative values should prompt engineering organizations to lead in evaluating their manpower resources. In the American Society of Agricultural Engineers, a small start in this direction has been possible by analysis of the data available in the roster of ASAE members. The data presented here are based on the roster as published in the 1955 AGRICULTURAL ENGINEERS YEARBOOK and reflect status of membership as of March 1. The figures given are approximate.

Total Membership

A total of 4318 members are accounted for in the classifications which follow. This represents a net gain in membership of 195 for the 11-month period over the 4123 accounted for in a preliminary survey of the 1954 roster of members.

Membership by Grades

Fellow	77
Member	1664
Associate Member	1849
Affiliate	725
Honorary	3

A word as to the significance of these grades may be in order. The grade of Fellow, as stated in the ASAE Consitution, "shall have honorary status, to which engineers of distinction may be elected but for which they may not apply." Elevation to this grade is by nomination by other Fellows and Members, rather than by application by the member concerned. Members of the grade of Member represent experienced engineers and administrators of engineering and related work. The Associate Member grade is that in which new graduates from professional engineering curriculums are enrolled until practical experience in agricultural engineering qualifies them for transfer to the grade of Member. Members of the grade of Affiliate are usually not engineers and are not primarily interested in the technical methods and procedures with which engineers are concerned. They are keenly interested, however, in progress in agricultural engineering, in the practical significance of that progress and its bearing on progress in agriculture and related business. Many of the Affiliates are distinguished individuals in agricultural science, agriculture, and the industries which serve agriculture. Honorary membership is accorded only a few specially distinguished individuals.

Membership by Major Technical Interest

Power and Machinery	1790
Soil and Water	815
Farm Structures	392
Rural Electric	486
None indicated	835

(NOTE: The above figures are not adjusted to show changes in interest indicated by members listed in both the 1954 and 1955 ASAE membership roster.)

There are a number of reasons why some members have not indicated a major interest in some one of the technical division fields. Some have substantially equal interests in two or more of these fields. This data is not generally readily available in the case of those elected to membership since publication of the previous issue of the membership roster.

Membership by Years of Enrollment

1907 (Charter Members)	5
1908-1915, inclusive	10
1916-1925, inclusive	141
1926-1935, inclusive	257
1936-1940, inclusive	343
1941-1945, inclusive	308
1946	181
1947	193
1948	314
1949	345
1950	402
1951	430
1952	480
1953	395
1954	387
1955 to March 1	127
	4318

This data emphasizes particularly the rapid growth of the Society beginning in 1946. It parallels and indicates approximately the growth in recognition of agricultural engineering and of the value of its service to agriculture.

Membership by Types of Employment

More than half of the members are associated with a total of something over 1000 private enterprises, mostly in the United States and Canada.

Approximately one-third are engaged in public service in the United States and Canada, including national government, state and provincial colleges and universities, other state and provincial agencies, area and local governmental activities.

The remainder include some in endowed foundations and other non-governmental, non-profit organizations, some in countries other than the United States and Canada, and some who have not indicated their employment.

Types of Employing Organizations

Private Enterprise. The variety of types of organizations in which ASAE members utilize their talents is surprising. As might be expected, many are employed by the larger farm equipment manufacturers. Other groups of manufacturers represented include industrial and domestic equipment manufacturers producing some items in the farm equipment field; smaller and more specialized manufacturers of field, barnyard, and household equipment; producers of electrical, mechanical, and structural component parts; producers of basic component materials such as chemicals, petroleu mproducts, metals and structural materials.

In the electric service field, both privately-owned electric power companies and REA cooperatives are active employers. Other types of utilities represented on a much smaller scale are railroads, air-lines, and pipe lines.

Distributors and dealers in farm equipment and supplies are one of the larger employing groups, as are trade associations and specialized agricultural producers and processors.

Somewhere over 100 members are owners, partners, operators or managers of individual farm enterprises, on a full-time basis, in addition to an undetermined number who have direct interest in one or more individual farms as an investment or side line.

In the highly professional field, members are associated with consulting engineering firms and with engineering and management services for farmers. Some are independent consulting engineers.

Other classes of private enterprise employing ASAE members in relatively small numbers include contractors, farm and trade publications, advertising agencies, financial institutions, land development companies, farm co-ops (other than electric), and specialized farm producers associations.

Public Service. Among the public service agencies, between 500 and 600 ASAE members are employed by the federal government. Under present conditions more than 150 of these are in the armed forces or are civilian employees of such defense department agencies as the Army Corps of Engineers.

The U.S. Department of Agriculture is the largest single employer, especially in the Soil Conservation Service and the Agricultural Research Service. Smaller numbers of ASAE members are assigned to the REA, FHA, PMA, Agricultural Extension Service, Office of Experiment Stations, and miscellaneous other agencies.

ASAE members are employed in somewhat lesser numbers by the U.S. Department of the Interior, principally in the Bureau of Reclamation and the Bureau of Indian Affairs.

Several members are employed in the U.S. Department of Commerce and miscellaneous other agencies.

In a notable special group are those employed on temporary or extended assignments in the Point Four or technical and economic aid programs, under several of the administrative agencies concerned.

The Canadian Department of Agriculture and its experiment station system is another important employer.

More than 700 members are employed by 50 states and territories and the provinces of Canada. By far the largest percentage are in the agricultural engineering departments of the colleges and universities. A sprinkling are in other agencies concerned with natural resources, food sanitation, pollution control, soil conservation, and a variety of other work related to state and local interests in business, engineering facilities, and agriculture.

Range of Professional Advancement

Grades of professional and business advancement range from graduate students, student engineers, trainees and other recent graduates to ownership or partnership in various types of business and professional practice; chief engineers and higher executive positions such as president and chairman of the board in large corporations, and department heads, deans and other high administrative posts in educational and other public agencies.

Considerably less than half of the members show official titles clearly indicating that they are engineers. Among these a few use the title "engineer" without modification. Most use one or more qualifying adjectives to indicate a technical branch of engineering, a function, or a grade of professional capacity, or some combination of two or all three of these variations. Those showing the title "agricultural engineer" are a small minority. Business, managerial and academic titles not including the word "engineering" are common.

Conclusion

ASAE membership represents a wide variety of talent, training, and contacts. It represents trained manpower applicable to professional and technical problems in agricultural engineering. Appreciation of this manpower and further study of its nature and capabilities may show additional ways in which the members can work together to advantage, with increased benefit to agriculture and the whole economy, and thus to themselves.

Illini Union Building—Air-conditioned headquarters for ASAE Annual Meeting

Illinois . . . the Heart of the Corn Belt . . . Extends You a Cordial Invitation to Attend the

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June 12-15, 1955

Typical aerial view of central Illinois in June

Technical sessions . . . field tours . . . women's events . . . children's activities . . . fun and fellowship. These are all a part of your ASAE Annual Meeting being held on the University of Illinois campus, June 12-15, 1955.

This meeting will be within the range of every ASAE member's pocketbook. University dormitory housing with or without food service will provide reasonable accommodations for all, and the central location permits easy access by all means of travel.

Air-conditioned meeting rooms will take the heat out of the technical sessions. Children's activities promise fun for all age groups, including nursery age, and leave mothers free for events planned specially for them. So bring the whole family. PLEASE MAKE YOUR RESERVATIONS NOW!

While in the State, Be Sure to See Scenic and Historic Illinois

NEWS SECTION

Quad City Section

"QUAD CITY SECTION" is the new name of the former Iowa-Illinois Section of the American Society of Agricultural Engineers. Members of the Section by a 4-to-1 vote adopted the new name in a recent letter ballot.

In adopting the new name for the Section, it is not intended that interest and participation of ASAE members in activities of the Section shall be limited to the Quad City area comprising the cities of Moline, Rock Island and East Moline, Ill., and Davenport, Ia., but rather that it shall identify the major interest of the Section, namely, farm power and machinery, to engineers of the farm equipment industry and of the suppliers to that industry.

Announcement of the change of name was made at the Section's annual meeting held at Hotel Blackhawk in Davenport on April 22. This year's meeting of the Section included a tour of the works of the J. I. Case Co. at Bettendorf, Ia., which was followed by a program devoted to corn harvesting. C. D. Johnson, an associate editor of *Successful Farming*, discussed new corn harvesting methods being employed by farmers. This was followed by an engineering discussion of the Case corn harvester by D. E. Burrough, special engineer at the Bettendorf Works of J. I. Case Co.

Concurrently with this program a special program was arranged for visiting high school seniors from Illinois and Iowa in which were presented opportunities for young men in the agricultural engineering field. The speakers on this program include Hobart Beresford and E. W. Lehmann, respectively, heads of the agricultural engineering departments at Iowa State College and the University of Illinois. The third speaker was Stanley M. Madill, executive engineer, John Deere Waterloo Tractor Works.

The Section dinner was held in the evening, and featured an address by the national president of ASAE, George B. Nutt, head, agricultural engineering department, Clemson Agricultural College.

At the annual business meeting of the Section held following the dinner program, Marlin E. Weakly, product test engineer at the East Moline Works, International Harvester Co., was elected chairman of the Section for the ensuing year. He succeeds Charles S. Morrison, chief engineer, product development department, Deere & Company.

The two new vice-chairmen of the Section are Roy E. Harrington, project engineer, product development department, Deere & Company, and Edward G. Rowlett, district engineer, The Torrington Co. The new Section secretary is Gerald W. Berryhill, junior engineer, Rock Island Works, J. I. Case Co., and the new treasurer is Mahlon L. Love of the engineering department of John Deere Harvester Works. The new nominating committee of the Section consists of R. G. Morgan (chairman), district manager, Timken Roller Bearing Co.; J. L. Marsh, supervisor of implement engineering, Rock Island Works, J. I. Case Co., and Ray Barkstrom, assistant chief engineer, East Moline Works, International Harvester Co.

ASAE Meetings Calendar

May 26—GEORGIA SECTION, Fleming, Ga.

June 3-5—TENNESSEE SECTION, Montgomery Bell State Park, Tenn.

June 12 to 15—48th ANNUAL MEETING, University of Illinois, Urbana

August 22-24—NORTH ATLANTIC SECTION, University of Connecticut, Storrs

December 12 to 14 — WINTER MEETING, Edgewater Beach Hotel, Chicago

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Mich.

Connecticut Section Meeting May 19

THE Connecticut Valley Section of the American Society of Agricultural Engineers will hold its next meeting May 19 in Plainville, Conn., a feature of which will be a tour through the General Electric Trumbull components plant in that city, as well as a tour of the Smith-Gates plant where is manufactured a variety of electrical equipment designed for poultry, livestock and other farm applications.

These tours will be held during the afternoon, and in the evening the Section will meet for dinner at which the guest speaker will be A. P. McGraw, regional manager, assemblies and component sales of the local General Electric plant. He will discuss adequate wiring and power distribution on present-day farms.

Darby New Chairman of West Virginia Section

JAMES L. DARBY, rural electrification specialist, Appalachian Electric Power Co., Point Pleasant, W. Va., was elected the new chairman of the West Virginia Section of the American Society of Agricultural Engineers at a Section meeting held on April 4 at Jackson's Mill, W. Va.

Russell H. Gist, state agent, agricultural extension division, West Virginia University, was re-elected vice-chairman of the Section.

The new secretary of the Section is W. H. Dickerson, Jr., agricultural engineering department, West Virginia University.

Hanson New Chairman Rocky Mountain Section

ELDON G. HANSON, head, agricultural engineering department, New Mexico A. & M. College, State College, was elected the new chairman of the Rocky Mountain Section of the ASAE at the April 11 meeting of the Section. He succeeds O. W. Israelsen.

Norman A. Evans, assistant professor of civil engineering and assistant irrigation engineer, Colorado A. & M. College, was elected the new vice-chairman of the Section, and the new secretary is Guy O. Woodward, extension specialist, University of Wyoming, Laramie.

The 1956 meeting of the Section is scheduled to be held on the campus of the New Mexico A. & M. College, State College.

Theo Brown Honored

THEO BROWN (Fellow ASAE), former member of the board of directors of Deere & Company, and for many years chairman of the farm safety committee of the Farm Equipment Institute, was honored last month with presentation of a National Safety Council testimonial booklet in recognition of his work in promoting farm safety. Planned as a surprise, the presentation was made at a luncheon at the Arsenal Golf Club in Rock Island, which was attended by officers and directors of Deere & Company and other friends of Mr. Brown, who is now retired.

The testimonial booklet presented to Mr. Brown contained 32 commendatory letters from officers of the National Safety Council and members of the Farm Conference, as well as other interesting material relating to Mr. Brown's contribution to farm safety work. This presentation was the outgrowth of the presentation made to Mr. Brown at the National Safety Conference last October, when he received the National Safety Council's highest award, "Citation for Distinguished Service to Safety."

Hurlbut New Chairman Mid-Central Section

LLOYD W. HURLBUT, chairman, agricultural engineering department, University of Nebraska, was elected chairman of the Mid-Central Section of the American Society of Agricultural Engineers at the Section meeting in St. Joseph, Mo., April 1 and 2. He succeeds Mack M. Jones.

Three new vice-chairmen were elected at the meeting: Dale O. Hull, extension agricultural engineer, Iowa State College; Robert M. George, Farm Engineering Supply, Inc., Mexico, Mo., and Martin K. Decker, instructor in agricultural engineering, Kansas State College.

Robert E. Stewart, professor of agricultural engineering, University of Missouri, was elected the new secretary of the Section.

At the business session of the meeting it was voted to amend the Section by-laws to include Iowa along with the other three states of Kansas, Missouri and Nebraska within the territory of Mid-Central Section.

Ag Engineers Needed Abroad

AGRICULTURAL engineers with experience in the development and use of farm machinery, irrigation, conservation, and machinery repairs are included in the lists of specialists in certain agricultural fields who are needed to represent the United States in technical assistance programs abroad.

Applicants are not required to take Civil Service examinations. However, they must meet high qualification standards established for these positions. Candidates preferably should be between 35 and 60 years of age. Salary rates range from $5907 to $9950 a year. Interested persons may submit Form 57, Application for Federal Employment (obtainable from first-class and second-class post offices), or write to Office of Personnel, U.S. Department of Agriculture, Washington 25, D. C.

NEWS OF ASAE MEMBERS

Chauncey W. Smith, Fellow of ASAE and a member of the Society since 1921, and for many years professor of agricultural engineering, University of Nebraska, will retire from his present connection with the University on July 1. He and Mrs. Smith will immediately leave for South America where he has accepted an assignment under the Point IV Program in agricultural engineering development work. He will be stationed in the Republic of Colombia where he will be engaged for at least two years' work at the government experiment station at Palmira.

C. W. SMITH

A graduate of the University of Nebraska in 1914, Mr. Smith has held the rank of professor of agricultural engineering since 1927. He became a member of the Tractor Testing Board in 1920, the year the Nebraska Tractor Testing Laboratory was established. He has been chairman of this Board since 1947. His valuable contributions on this Board are represented by the many fine services rendered by the Laboratory and the international reputation it has gained.

An honorary dinner for Professor and Mrs. Smith will be held on May 13 in the Student Union Building on the University of Nebraska campus in recognition of their years of service to Nebraska and the University.

Warren E. Garner has resigned as assistant agricultural engineer at the Georgia Agricultural Experiment Station at Athens to accept an appointment as agricultural engineer with the new USDA Southeastern Cotton Ginning Research Laboratory at Clemson, S. C. The laboratory buildings are currently under construction and he is the Laboratory's representative at the site pending arrival of Charles A. Bennett and other personnel to be assigned.

John Effa announces the organization of the John Effa Supply Company which is a merger of the John Effa Irrigation Company and the Aerovent Fan & Equipment Company of Illinois, Inc. The address of the new company is West Chicago, Ill., and it will sell at wholesale a complete line of sprinkler irrigation equipment, pumping equipment, crop-drying equipment, dairy-equipment supplies, and automatic feed-handling equipment.

Jeff E. Flanagan has been appointed regional planning consultant for International Development Services, Inc. His new address will be U.S. Operations Mission, American Embassy Quatemala City, Quatemala. He was formerly irrigation engineer with Michael Baker, Jr., Inc., consulting engineers, in Pennsylvania.

Unus F. Earp has been given new duties as a member of the agricultural engineering department staff of Virginia Polytechnic Institute; he will serve as course adviser to agricultural engineering students and will head the college division of the agricultural engineering department.

Carlton E. Johnson has resigned as assistant professor in the farm mechanics section of the agricultural engineering department, Iowa State College, to accept appointment as teacher-trainer in the farm mechanics section of the agricultural engineering department at Ohio State University, with the rank of associate professor.

Sydner H. Byrne, professor of agricultural engineering, Virginia Polytechnic Institute, was recently appointed assistant dean of engineering and architecture at VPI.

Mr. Byrne, a native of Virginia, received his B.S. degree in agricultural engineering in 1930 and his M.S. degree in 1933, both from VPI. In 1954 he received his Ph.D. degree in agricultural engineering from Iowa State College. Through his graduate training, which includes agricultural, civil, architectural and mechanical engineering, Mr. Byrne has obtained a well-rounded engineering background which especially qualifies him for the new position of assistant dean.

S. H. BYRNE

Following graduation in 1930, Mr. Byrne joined the agricultural engineering staff at VPI, but in 1932 he went to Roanoke College as engineering instructor and course adviser for engineering students. He returned to VPI in 1936 as assistant professor of agricultural engineering. During World War II he served on the faculty of the applied mechanics department and assisted in the direction of the Army Specialized Training Program at VPI. He was also the ASTP finance officer. He has been a member of the VPI agricultural engineering department staff since 1936 and has been course adviser to agricultural engineering students since 1949.

Robert H. Black was recently appointed advertising manager of Strong-Scott Mfg. Co., Minneapolis, manufacturers of machinery and equipment for the grain and feed industries. Since 1951 Mr. Black has been serving as vice-president of the Seedburo Equipment Co.

R. H. BLACK

Mr. Black's career in the grain and feed industry dates back to 1913 when he graduated from Upper Iowa University and became active in grain research for the U.S. Department of Agriculture. After several years of this work, he was appointed federal grain supervisor for the Minneapolis District, and later became assistant director of the USDA grain branch in Washington. Mr. Black's present employer has been carrying on a research and development program during the past three years which has resulted in the introduction of eleven new machines for modernizing methods of grain handling and processing.

Loyd Johnson, who has been employed by Cia Agricola Guatemala, at Tiquisate, Guatemala, recently accepted employment in the agricultural department of the Tela Railroad Company and is located at La Lima, Honduras, C. A.

Rodney O. Martin was recently appointed extension agricultural engineer at the University of Maine. He is an agricultural engineering graduate of the University of Maine, having received both the bachelor's and master's degrees in agricultural engineering at that institute. For the past two years he has been serving as assistant in agricultural engineering for the Maine Agricultural Experiment Station where he has been conducting research on potato-handling equipment. More recently he has been stationed at the Maine Potato Handling Research Center at Aroostook Farm in Presque Isle.

NECROLOGY

William A. Roberts, president of Allis-Chalmers Mfg. Co., passed away in Milwaukee, April 12, at the age of 57, following a brief illness. He had suffered a heart attack on April 1.

W. A. ROBERTS

Born at Osceola, Mo., he left his father's farm at the age of sixteen to make his own way in the world. His first connection with the Allis-Chalmers organization started in 1924, as agricultural sales representative at the Wichita Branch of the Tractor Division. After a few year there and with the Company's sales organization in Canada, he resigned to become a partner in a farm equipment distributor dealership in Canada. Rejoining the Company at its home office in 1930, he was soon promoted to agricultural sales manager. In 1931 he was made general sales manager of the Tractor Division, and in 1941 manager of the Division. Next, in 1943, he was elected vice-president in charge of the Division, in 1947 executive vice-president, in 1948 a Company director and member of the Executive Committee, and in 1951 president.

During his career he contributed materially to the introduction of rubber tires as standard equipment on tractors; the development of the small tractor and combine, and the rear engine row-crop tractor. In recent years he had also directed a major plant expansion and modernization program for the Company.

A member of ASAE since 1944, he was especially active in the Farm Equipment Institute which he had served as president and member of the Executive Committee. He was a member of the President's Advisory Committee on the National Highway Program, a member of the National Committee of Boys and Girls Club Work, Inc., an active supporter of 4-H clubs and the Future Farmers of America, and other national, state and local civic and trade groups. He is survived by his parents, Mr. and Mrs. Charles Roberts of Fort Scott, Kans.

(Continued on page 346)

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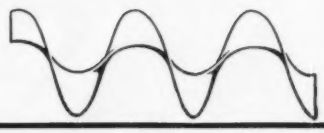
ONE-PIECE HELICOID FLIGHTING		Continuous flighting has greater smoothness and strength. Link-Belt also builds many different types to meet your special needs—cut flight, short pitch, ribbon flight, tapered flight, double flight to name a few.
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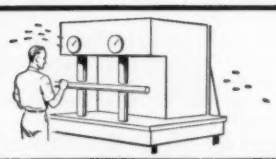
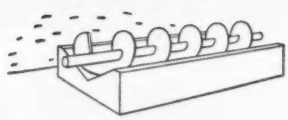
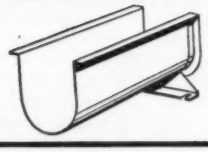
STEELS THAT MEET OUR SPECIFICATIONS		Selected steel for flighting, assures a uniform, smooth, accurately rolled product.
STRAIGHTNESS		Straightness of the completed auger is checked before shipping. Extra care is taken in handling and loading.
ALL COMPONENTS		A full line of related equipment can be supplied by Link-Belt specially engineered for your requirements. This includes troughs, spouts, hangers, drives.

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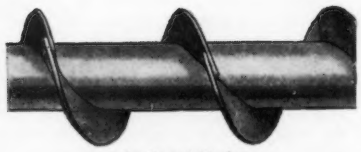
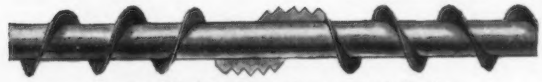


Sectional-flight

Helicoid flight with plain beater

Helicoid flight

Unmounted Helicoid flighting



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NECROLOGY

(Continued from page 344)

Earl B. Baker, owner and manager of Bay Creek Farm, Baxley, Ga., passed away November 18, 1954, of acute leukemia. Born at Fairmount, Ill., in 1894, he graduated in ceramic engineering at the University of Illinois. He was first employed by the Bureau of Standards and stationed at Ohio State University to conduct efficiency tests on kilns used in the manufacture of heavy clay wares throughout the Midwest. After three years he transferred to work with industry, in charge of research and plant control for the Detroit Star Grinding Wheel Co. In 1935 he moved to Baxley, Ga., to establish a private practice as a consultant to abrasive manufacturers, and develop other personal business interests. In 1941 he purchased farm land there, started experimenting with hybrid grasses, corn, oats and other crops, and became interested in soil conservation.

One of many activities in which he won acclaim as a public spirited citizen and effective civic worker was a rehabilitation project on the land of a Baptist Children's Home near Baxley. Through his leadership and success in securing the cooperation of many others, the 1300 acres of the Home were transferred in one day into a model farm layout with provision for soil conservation and improvement.

Mr. Baker had served a term as president of the Baxley Kiwanis Club, first president of the Appling County Chamber of Commerce, first president of the Tri-County Concert Association, and first chairman of the Housing Authority of the City of Baxley. He was also active and had held offices in the Altamaha Soil Conservation District, the Farmers Mutual Exchange, and the Farm Bureau. He was a Mason and a member of the First Methodist Church. He had become a member of ASAE in 1953. He is survived by his wife, Mrs. Olga Baker, and a brother Froman C. Baker of Fairmount, Illinois.

Joe B. Butler, professor and chairman, department of civil engineering, Missouri School of Mines, passed away March 27 at a hospital in St. Louis at the age of 59. A native of Oklahoma, he studied agricultural and civil engineering at Oklahoma A & M College, receiving his bachelor's degree in civil engineering in 1915. His early professional career included two years as lieutenant in the Army Corps of Engineers during World War I, a year in railroad valuation work with the Interstate Commerce Commission, and a variety of railroad and highway survey and highway construction. Since 1920 he had been associated with the civil engineering department at the Missouri School of Mines, starting as instructor and earning promotions in rapid succession. In 1931 he was named professor and head of the department. The School awarded him the professional CE degree in 1922. In 1924 he received a bachelor's degree in education from Oklahoma A & M College and a master's degree in civil engineering from the Missouri School of Mines. His teaching included subject matter in the fields of irrigation and soil erosion control. A member of ASAE since 1952, he was also active in the American Society of Civil Engineers and the American Society of Engineering Education.

NEW BULLETINS

The following bulletins have been received recently from the National Institute of Agricultural Engineering, Wrest Park, Silsoe, Bedfordshire, England.

A Flowmeter for Liquids—Report No. 44

A Method of Estimating Water Requirements for Crops Grown in the Open—Technical Memorandum No. 85.

An Integrator for the Rapid Examination of Continuous Records—Technical Memorandum No. 110.

The Estimation of Lime Sulfur Residue—Technical Memorandum No. 115.

The Determination of Organic Carbon: Dry Combustion Method—Technical Memorandum No. 117.

Agricultural and Horticultural Engineering Abstracts, Vo. 6, 1955, No. 1.

Environmental Physiology, and Shelter Engineering, with Special Reference to Domestic Animals. Missouri Agricultural Experiment Station (Columbia) Research Bulletins.

XXV. The Effect of Wind on Milk Production, Feed and Water Consumption and Body Weight in Dairy Cattle, by Brody Ragsdale, Thompson, and Worstell Research Bulletin 545 (April 1954). Variations in results are reported for different breeds and individual animals. There was some indication that air movement generally decreased the depressing effects of high temperatures and increased food consumption and heat production at low temperatures.

XXVI. The Effect of Wind on Evaporative Cooling and Surface Temperature in Dairy Cattle, by Thompson, Yeck, Worstell and Brody Research Bulletin 548 (June 1954). A higher tolerable temperature is reported for conditions in which increased convective cooling by wind is added to vaporization cooling.

XXVII. Influence of Wind on Heat Exchange and Body Temperature Regulation in Jersey, Holstein, Brown Swiss, and Brahman Cattle, by Kibler and Brody. Research Bulletin 552, (June 1954). Wind at low temperatures is shown to have a generally unfavorable influence on warm climate Brahman cattle, while wind at high temperature has a generally favorable influence, over no wind at the same temperatures, for cool climate cattle.

House Building by Farm Owners in North Carolina, by James W. Green. North Carolina Agricultural Experiment Station (Raleigh) Bulletin 391 (September, 1954). This is described as a study of the sociological process of building farm houses. Based on study of a statewide sample of 266 North Carolina farm families which built new houses during 1948-50, it reports on why, how, and how well they built, in terms of need, planning, dealing with builders, use of labor, and financing. Illustrations and pictorial graphs add materially to give interest and meaning to the data presented.

Frost Protection with Sprinkler Irrigation, by John R. Davis. Michigan State College (East Lansing) Extension Bulletin 327 (April 1955). A 12-page bulletin describing the sprinkler irrigation method of frost control, with special application to the higher value crops. It covers possible benefits and limitations of the method, the theory behind it, using weather forecasts, temperature limitations, crops protected and possible damage to crops and soils. Particular attention is given to basic irrigation equipment design for frost protection, and the techniques of using the equipment. Water requirements, labor requirements, comparison of this method with others, and detailed operation procedure are also included.

Environmental Physiology and Shelter Engineering, with Special Reference to Domestic Animals. Missouri Agricultural Experiment Station (Columbia) Research Bulletins.

XXVIII. The Thermal Effects of Radiation Intensity (Light) on Milk Production, Feed and Water Consumption, and Body Weight in Holstein, Jersey and Brahman Cows at Air Temperatures 45, 70 and 80 F, by Brody, Ragsdale, Thompson, and Worstell. Research Bulletin 556 (July 1954). High radiation intensity showed a depressing effect on normal body frictions at the higher temperature ranges, for the less heat-resisting Holsteins and Jerseys.

XXIX. Effect of Radiation Intensity on Hair and Skin Temperatures and on Respiration Rates of Holstein, Jersey, and Brahman Cattle at Air Temperatures 45, 70 and 80 F, by Stewart and Brody. Research Bulletin 561 (September 1954). Hair and skin temperatures reportedly increased with increasing radiation intensity, but respiration rate did not increase proportionately, except possibly in the Brahmans.

Irrigation in Kentucky, by Earl G. Welch. Kentucky Agricultural Extension (Lexington) Circular 528 (February 1955). A guide to practice and to equipment selection.

Effectiveness of Nails Versus Staples for Fastening Insulating Sheathing, by E. George Stern. Virginia Polytechnic Institute Wood Research Laboratory (Blacksburg). Special Report No. 19 (February 1955). Six pages of performance data generally favorable to helically threaded screw-nails.

Prepackaging Apples in Film Bags, by J. H. Levin and H. R. Gaston. Michigan Agricultural Experiment Station (East Lansing) Special Bulletin 396 (February 1955). A report on equipment, layout, and methods indicating opportunities for improvement in the practice of this rapidly developing method of packaging.

Using LP Gas as a Tractor Fuel by C. L. Day, M. D. Cannon, and M. M. Jones. Missouri Agricultural Experiment Station (Columbia) Bulletin 635 (October 1954). An 8-page 8½ x 11-inch bulletin reporting briefly on an LP gas tractor survey, tests comparing LP gas and gasoline, and recommended changes for converting tractors to LP gas.

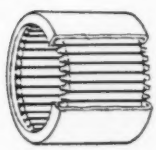
Field Experiences with Spray Nozzles in the Tropics, by F. L. Vanderplank. Reprint from World Crops (Leonard Hill, Lt., Stratford House, 9 Eden St., London, NW 1, England). An entomologist's report on performance in terms of droplet size and distribution.

How to Make Your Windows Increase Poultry Profits. Libbey-Owens-Ford Glass Co., Toledo 3, Ohio. Eight 8½ x 11-inch pages, illustrated, on design and application methods.

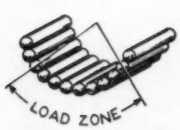
How to Use the Sun's Heat in Your Poultry Buildings. Libbey-Owens-Ford Glass Co., Toledo 3, Ohio. This is a 12-page, 8½ x 11-inch reprint of four articles on related subjects which originally appeared in poultry publications.

TORRINGTON

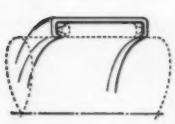
DC needle bearings give high-capacity performance in minimum space



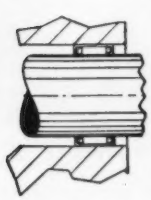
Unique construction—accurately drawn, surface-hardened shell retains rollers and serves as outer raceway.



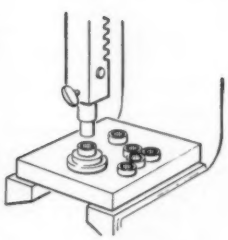
Full complement of small diameter rollers—precision-ground and through-hardened—assures top capacity by distributing load over large number of contacts.



Turned-in lips of the case-hardened outer shell keep dirt and grit out, lubricants in—while retaining trunnion ends of rollers. All wear surfaces of outer race are case-hardened.



No inner race required on surface-hardened shafts—reduces space requirements, lowers unit costs.



Simple assembly—arbor press seats bearing in round housing bore. No collars, shoulders or retaining rings needed.

Closed end type DC Needle Bearings are available for stub shaft applications. The closed end provides a perfect seal at no extra cost.

Needle Bearings are made in a Precision Series for most applications and an Extra Precision Series where low radial play and minimum eccentricity are required. Easy lubrication through optional hole in shell or through hole in shaft assures long service life. Bearings can be pre-packed with suitable grease for those applications requiring grease lubrication.

See our new Needle Bearing Catalog in the 1955 Sweet's Product Design File—or write direct for Catalog No. 55.

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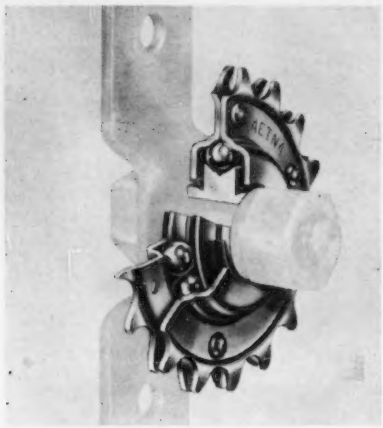
NEW PRODUCTS CATALOGS

Ball-Bearing Sprocket Idler

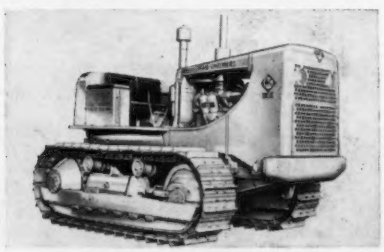
Aetna Ball & Roller Bearing Co., division of Parkersburg-Aetna Corp., 4600 Schubert Ave., Chicago 39, Ill., announces that it is introducing a new, inexpensive unit combining sprocket idler and anti-friction bearing which has been developed for agricultural equipment applications. One of the



designed features of the unit is a one-piece, self-contouring, synethetic rubber seal, originated by Aetna, that encloses the large-capacity, factory-packed lubricant chamber. The bearing outer race and sprocket sheave is of casehardened, heavy-gage pressed steel. This unit is one of a new line of agricultural mounted bearing units introduced by the company, including belt idler, grain drill and disk harrow units. The line also includes a general utility unit designated as an adapter bearing because of its adaptability to both agricultural and industrial equipment applications.

New Diesel Crawler Tractor

Allis-Chalmers Mfg. Co., Tractor Div., Milwaukee 1, Wis., announces the second new crawler tractor this year, the HD-16, available with torque-converter drive and standard transmission. It is equipped with the new A-C 6-cylinder 844-cu-in diesel engine which develops 150 net engine hp at



1800 rpm with torque converter and 140 hp at 1600 rpm with standard transmission. The maximum drawbar pull of 60,000 lb is obtained with the torque converter drive; with the standard transmission it has a maximum drawbar pull of 31,700 lb at rated engine speed.

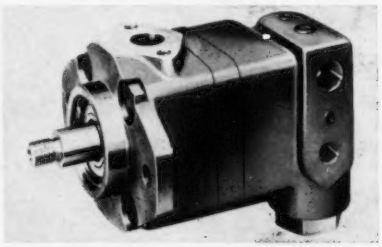
Standard equipment includes hydraulic steering controls; wrap-around radiator guard; 20-in heat-treated track shoes; positive-seal heavy-duty truck wheels, heavy-duty front idlers and support rollers; guards for truck wheels, front idlers, and sprockets; full-width crank-case guard; muffler; front-pull hook; electric starting and lighting equipment; front bumper, and pusher-type fan. A new line of matched equipment such as dozers, shovels, scrapers, power-control units and sideboom is designed especially for this tractor.

Farm Building Catalog

Great Lakes Steel Corp., Stran-Steel Div., Ecorse, Detroit 29, Mich., will send on request to interested readers a copy of its new farm catalog "Quonset Buildings for Every Farm Use." It features buildings that have been engineered to meet many specific farm needs such as storage of farm machinery, drying, conditioning, and storage of grain, housing for livestock, and storing, drying and self-feeding of hay. Dimensions and descriptions of each type of building, together with illustrations of accessories and packages supplied to adapt these buildings for specific uses, are given. Tables of capacities, space requirements and other pertinent data are also included.

Oil-Hydraulic Pump

Vickers, Inc., 1400 Oakman Blvd., Detroit 32, Mich., announces a new oil-hydraulic pump (Series VU-100) designed for use in an accumulator system which provides oil-hydraulic power for cold starting of gasoline line or diesel engines in large agricultural or other mobile equipment. The pump includes an integral unloading valve for compactness and system simplification. It is suit-



able for installations using working pressures up to 2500 psi and speeds up to 3600 rpm. The unit delivers 1.5 gpm, at 2000 rpm and 2000 psi. It can be driven directly or with a gear drive. The cover containing the accumulator connection ports is designed to permit assembly in any of four different positions, thus enabling the pump to meet a variety of installation position requirements. It is available with standard flange-type mountings only.

A New 5-Foot Combine

J. I. Case Co., Racine, Wis., announces the new Case model 55 combine, which is especially designed for small-arceage farmers and work in irregular fields, but which retains the efficiency of the larger machines. The company states that a 2-plow tractor

provides ample power for this power-take-off machine.

The machine is equipped with a channel-type swing-over drawbar which reduces the over-all width for transport along farm lanes and through gates and along highways.

The header is vertically adjustable from ¾ inch to 26 inches above the ground. A spring-balanced manual lift is standard, although a hydraulic header lift is optionally available.

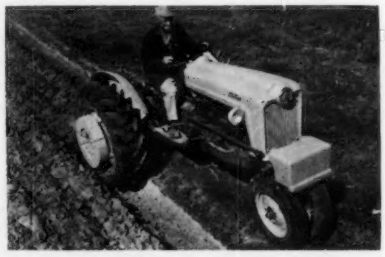
Implement Chain Book

Chain Belt Co., Milwaukee 1, Wis., will send on request to interested readers a copy of its new 64-page bulletin (No. 54-54) titled "Rex Agricultural Implement Chains,"

which deals with specifications, production, and application theory of the company's steel detachable chain. Appropriate pictures show various uses of the chain in drive and conveyor applications on farm machinery.

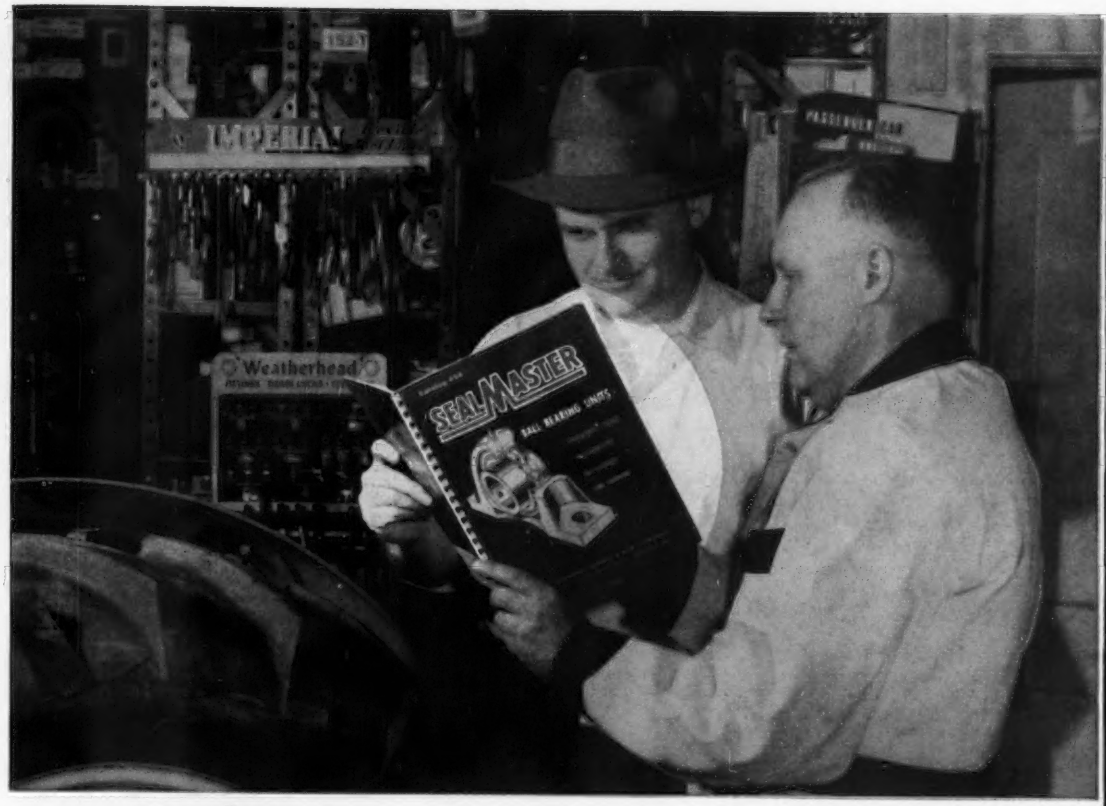
New Tricycle Tractor

The Tractor & Implement Div., Ford Motor Co., Birmingham, Mich., announces that it has added three new tricycle farm tractors and companion front-mounted implements to its line of farm machinery. Powerspread rear wheels are a major feature of the new tractors, in which the operator uses the power of the tractor to turn the wheel disks to obtain the desired spacing in one-inch increments from 56 to 76 inches. Front-mounted equipment designed for use with these tractors includes two and



four-row cultivators with planter, fertilizer and side-dresser attachments.

All three models have, as standard equipment, three-point implement hitch, built-in live-action hydraulic system, weatherproofed ignition, headlights and taillight, safety starter which operates only in neutral, one-piece front wheel pedestal with two-bearing design, automotive-type steering, ignition key lock, rear power take-off, and several other features. *(Continued on page 350)*



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One of the most significant trends in the farm field during the past year has been the increasing demand for quality in farm machinery. Initial purchasing price is of importance to the farmer but operational expense over the long haul is the **big** thing. The machinery market is competitive and the farmer has become a careful buyer. He's interested in a piece of machinery that will give him top performance and eliminate costly hours of maintenance. No component you build into your product will mean more to its efficient performance than the bearing units carrying the load. Insist on SEALMASTER and be sure!

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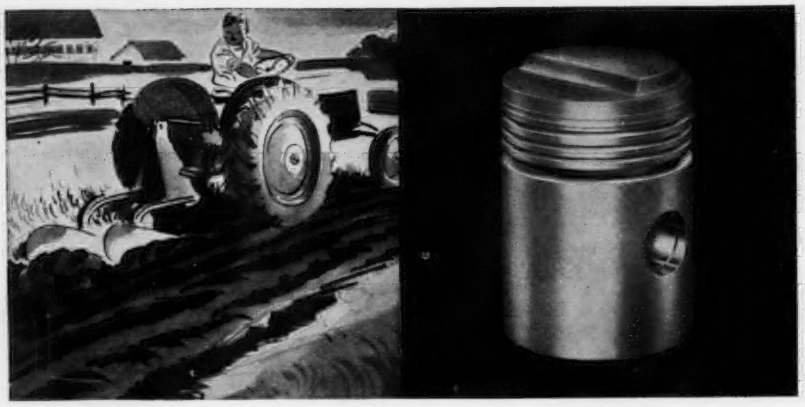
Fishing and Farming



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In the case of the tractor, it's any one of several parts, including the piston, that is produced by Thompson — with the outboard motor, one of the parts produced by Thompson is the propeller.

Outboard motor propellers and tractor engine pistons are but two of the many light, strong, durable castings designed, developed and manufactured by Thompson for a diversified list of customer uses. Today Thompson is producing light metal castings for such products as buses and garbage disposers; washing machines and jet planes; automobiles and industrial engines; ice scoops and aircraft engines.

Behind this ability to aid all forms of industry are over 50 years experience in research and manufacture of precision metal parts. Regardless of your product, if you use castings, Thompson's creative engineers will gladly show you where and how you can simplify your operations and save on costs with Thompson Light Metals Castings.

For a detailed description of the Thompson Light Metals facilities which are available to you, send for your free copy of "Creative Castings." Just write to Dept. AE-2, Light Metals Division, Thompson Products, Inc., 2269 Ashland Road, Cleveland 3, Ohio.

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New Products and Catalogs

(Continued from page 348)

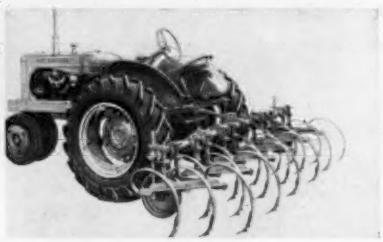
Truss-Frame Plow

The Oliver Corp., 400 W. Madison St., Chicago 6, Ill., announces a new four to five-bottom truss-frame-type moldboard plow in which a heavy 5-in pipe is used to tie the bottoms together. It is designated as Model 4440 and is convertible in both size

and furrow-cutting width. It can be converted from a 4-bottom to a 5-bottom plow; furrow-cutting width is 14 or 16 inches. Each bottom is equipped with a trip-spring release. All three wheels are equipped with sealed-for-life roller bearings and carry popular-size, 15-in tires.

Rear-Mounted Field Cultivator

Allis-Chalmers Mfg. Co., Tractor Div., Milwaukee, Wis., has added the WD-45 12-foot-wide rear-mounted, hydraulically controlled, heavy-duty field cultivator to its farm implement line, to match the company's WD-45 tractor. The cultivator has 18 heavy-duty spring teeth made of heat-treated spring

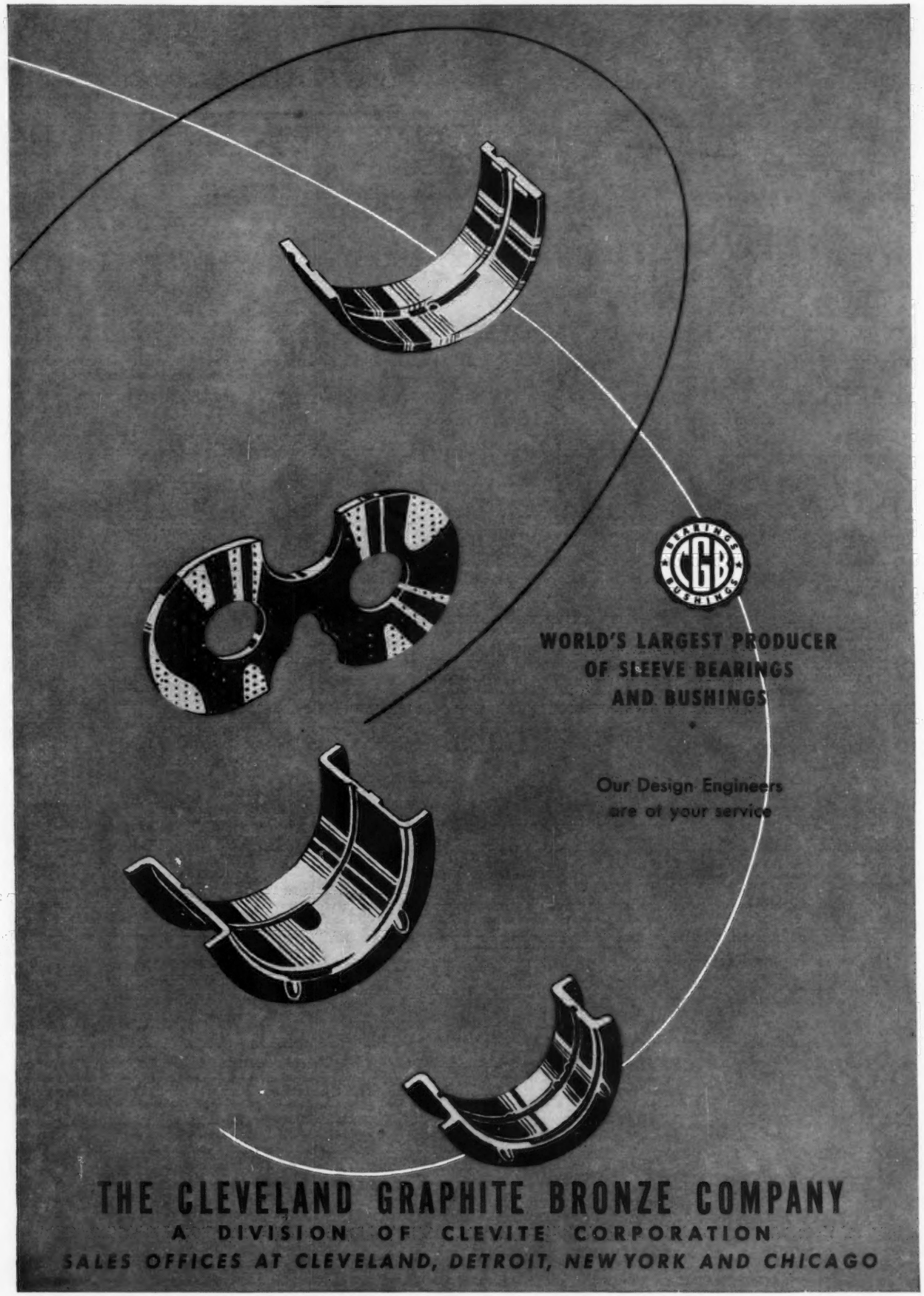


steel. The teeth are spaced 8 inches apart laterally and 10 inches fore and aft for trash clearance. Each tooth has 2 x 10-inch double-pointed reversible shovels. The mounting frame supports a 2¼-inch square by 136-inch long tool bar of solid high carbon steel.

All-Steel Wagon Box

New Idea Farm Equipment Co., Coldwater, Ohio, announces that it has developed a newly engineered all-steel wagon box designed for grain-tight, heavy hauling. Among the major features are sturdy, bolted

construction with replaceable front, back, sides and bottom; sliding self-locking chute door with down-to-a-trickle unloading control; three large gusset plates on each side to keep the box rigid and in alignment; rolled top edges for greater strength, and 100-bushel capacity tested at 8500 pounds.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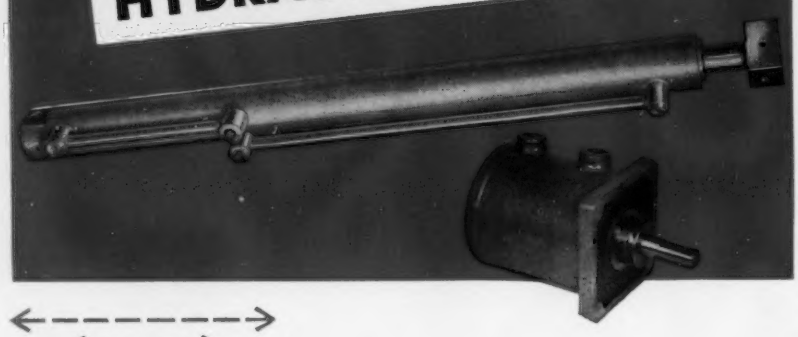

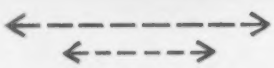

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Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Abayaratna, Ananda — Assistant engineer, Agricultural Research Station, Maha Illuppallama, Ceylon

Anderson, Billy B.—Design draftsman, J. I. Case Co., Burlington, Iowa. (Mail) 1140 Franklin St.

Auch Moody, Herbert B. — Area engineer (SCS), USDA, Broken Bow, Nebr.

Ball, Wilbur P. — Instructor in agricultural engineering, Iowa State College, Ames, Iowa. (Mail) 2005 Pammel Court

Bradley, James E.—Student in agricultural engineering, Oklahoma A. & M. College, Stillwater, Okla. (Mail) RR 4

Breitfuss, Thomas K.—Assistant to managing director, American Concrete Pipe Assn., 228 No. LaSalle St., Chicago 1, Ill.

Brown, Grover W. Jr.—Product education manager, The Doolittle Tractor & Implement Co., Charlotte, N. C. (Mail) 2525 Remount Circle

Bryan, Cecil S.—Irrigation engineer, Foreign Operations Administration, American Embassy, Bogota, Colombia, S. A.

Burton, Waverly, M.—Special representative, Caterpillar Tractor Co. (Mail) 2795 Nicholson Dr., Baton Rouge, La.

Campbell, William C.—Vice-President and treasurer, Campbell Metal Products Co., Inc., West Middlesex, Pa. (Mail) PO Box 235

Clark, Dana A.—Sales engineer, Delco Products Div., G.M.C. (Mail) 301 N. School St., Normal, Ill.

DeYoung, Lee B.—Senior advertising editor of farm equipment, International Harvester Co. (Mail) 126 Ash St., Park Forest, Ill.

Diao, Gregorio A.—Instructor of agricultural engineering, Mindanao Agricultural College. (Mail) 507 E. Healey St., Champaign, Ill.

Dobyns, Owen T.—State conservation engineer (SCS), USDA. (Mail) 211 W. North Second St., Shelbyville, Ill.

Doyle, Donald V.—Research engineer, Forest Products Laboratory, USDA, Madison 5, Wis.

Eaton, Herbert N. — Consulting engineer, 13,809 Colesville Road, Silver Spring, Md.

Engvall, Elmer O.—Designer, International Harvester Co. (Mail) 1138 24th St., Moline, Ill.

Fiester, Fred L. — Electrification adviser, Claverack Electric Cooperative, Inc., 507 Main St., Towanda, Pa.

Fisher, Howard F.—Bridge designer, Iowa State Highway Commission, Ames, Iowa. (Mail) 221 Hyland

Fitzsimmons, Jerome F. — Manager, consumer research dept., Tractor & Implement Div., Ford Motor Co., 2500 E. Maple Rd., Birmingham, Mich.

Flesher, Virgil H. — Research and graduate assistant in agricultural engineering, South Dakota State College, Brookings, S. D.

Frenette, Joseph N.—Service manager, farm machinery dept., La Cooperative Federee de Quebec, Montreal, Que., Canada. (Mail) 5 9th Ave., Pte-Aux-Trembles

Giesecke, Raymond C.—Postgraduate student in agricultural engineering, A. & M.

(Continued from page 354)

Here's a bolt whose weakness is its strength!

Making a bolt that fails precisely when it should requires specialized manufacturing skills.

This is the job New Holland Machine Company, farm equipment manufacturers, turned over to RB&W. The bolt is used on the flywheel of a New Holland baler. "Critical" is a weak word for its importance to the baler.

If the baler picks up a foreign object such as a rock or stone, this bolt *must* snap to prevent gear breakage. But it can't fail too soon—when the baler eats up extra-heavy windrows, for example. If it failed every time this happened, the farmer would spend all day replacing bolts — instead of making hay.

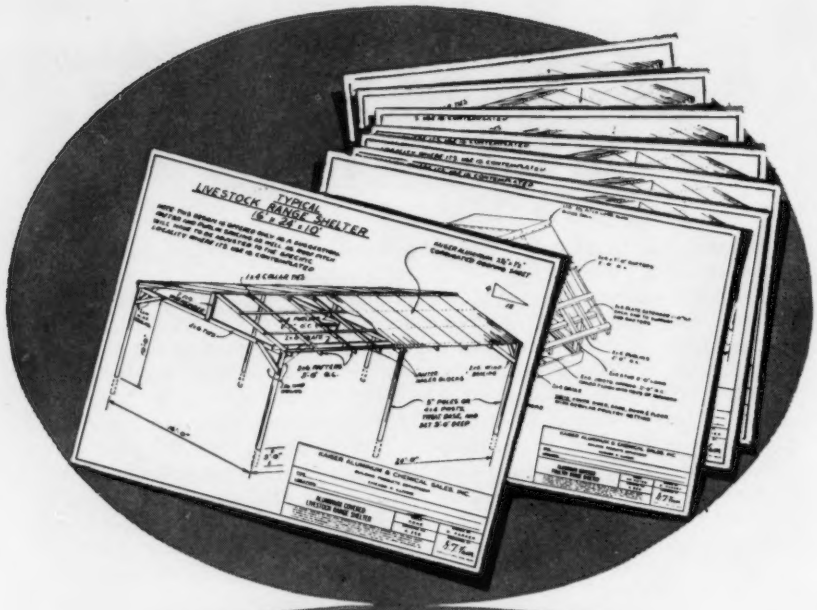
RB&W worked hand-in-glove with New Holland engineers in the tough job of heat-treating a standard machine bolt to these exacting specifications. It took a lot of ingenuity — but paid off. You can expect the same kind of service, cooperation and end product when you drop your fastener problem in our hopper. RUSSELL, BURDSALL & WARD BOLT AND NUT CO., Port Chester, N.Y.

UP TO TWELVE TONS OF HAY AN HOUR is the capacity of New Holland's Super 77 power take-off baler. With every minute vital in harvesting, farmers can't take chances on machinery failure — so New Holland built rugged parts into the Super 77, gave it extra-large capacity for fast, reliable operation.

RB&W RUSSELL, BURDSALL & WARD

110 YEARS MAKING STRONG THE THINGS THAT MAKE AMERICA STRONG

Plants at: PORT CHESTER, N.Y.; CORAOPOLIS, PA.; ROCK FALLS, ILL.; LOS ANGELES, CALIF. *Additional sales offices at:* ARDMORE (PHILA.), PA.; PITTSBURGH; DETROIT; CHICAGO; DALLAS; SAN FRANCISCO. *Sales agents at:* NEW ORLEANS, DENVER, SEATTLE. *Distributors from coast to coast.*



Valuable help

FOR VO-AG TEACHERS AND COUNTY AGENTS

Kaiser Aluminum Farm Building Plans give Maximum Economy plus Strength and Utility

Vo-ag teachers and county agents all over the country are now making effective use of these eight new Kaiser Aluminum plans.

As a result, many farmers are getting the finest farm buildings they've ever had. Here's why:

The new Kaiser Aluminum building plans were designed by agricultural engineering specialists—most featuring low-cost pole-type construction. They provide maximum economy, consistent with maximum strength and utility.

Each plan is a *complete set of blueprints*—including section details, erection instructions, elevations, bill of materials!

In addition, each plan enables farmers to take full advantage of Kaiser Aluminum Roofing—in standard sheets, or in the new 48"-wide size.

Among its many advantages are light weight with strength, reflection of hot summer sun, retention of winter warmth, long life with no red rust streaks, no rotting, no warping. And Kaiser Aluminum Roofing is economical because it requires less maintenance, is easily applied, never needs paint. Permanently attractive. It's the performance tested aluminum roofing material.

Kaiser Aluminum

The Quality Roofing for Better Farm Buildings

ATTACH THIS COUPON TO YOUR LETTERHEAD AND MAIL TODAY!
A sample set of plans will be sent without obligation to agricultural engineers and county agents.

KAISER ALUMINUM & CHEMICAL SALES, INC.
FARM BUILDING SERVICE
5529 KAISER BUILDING, OAKLAND 12, CALIFORNIA

Please send a set of the plans to:

NAME_____

ORGANIZATION_____

ADDRESS_____ CITY AND STATE_____

Applicants for Membership

(Continued from page 352)

College of Texas, College Station, Tex. (Mail) Box 4252

Greenman, Harlan R.—Designer, Tractor & Implement Div., Ford Motor Co. (Mail) 896 Argyle, Pontiac, Mich.

Hadler, Howard D.—Junior engineer, J. I. Case Co. (Mail) RR 1, Rantoul, Ill.

Hamilton, James H.—Warehouse manager, The Doolittle Tractor & Implement Co., Charlotte, N. C. (Mail) PO Box 1192

Hammack, Doyle F.—Agricultural engineer (SCS), USDA, Sweetwater, Tex. (Mail) PO Box 605

Hefner, John L. Jr.—Salesman and agricultural engineer, The Krick-Tyndall Co., Decatur, Ind. (Mail) 940 Walnut St.

Hill, Merritt D.—Assistant general manager, Tractor & Implement Div., Ford Motor Co., 2500 E. Maple Rd., Birmingham, Mich.

Hoag, Robert H. — Staff assistant trainee, Ralston-Purina Co., Battle Creek, Mich. (Mail) 62 N. Cedar Ave.

Hunnicutt, Howard—Agricultural engineer, Agricultural Marketing Service, Long Island Vegetable Research Farm, Riverhead, N. Y.

Jaska, Ernest H. — Agricultural engineer, Texas Power & Light Co. (Mail) Ross, Tex.

Jovellanos, Raymundo E. — Instructor in agricultural engineering, Central Luzon Agricultural College. (Mail) 507 E. Healey, Champaign, Ill.

Keese, Carroll W.—Instructor in agricultural engineering, A. & M. College of Texas, College Station, Tex.

Lange, George M.—Vice-President of sales, Tyson Bearing Corp., Massillon, Ohio

Lawhon, Lester F. — Irrigation engineer (SCS), USDA, Fort Worth 10, Tex. (Mail) 3244 Hemphill

Leach, Norman E. — Agricultural engineer (SCS), USDA, Terrell, Tex. (Mail) 1005 N. Frances

Lenois, Earl R.—Lt., meteorologist, USAF, Lake Charles, La. (Mail) 1115 Pithon St.

Lyles, Leon—Student in agricultural engineering, Oklahoma A. & M. College. (Mail) Box 903, Wetumka, Okla.

Lynch, Patrick, C.—Rural engineer, Georgia Power Co., 15 Forsyth St. S.W., Atlanta, Ga.

Morrissey, Lester G.—Instructor in agricultural engineering, University of Wisconsin, Madison, Wis. (Mail) 619 Eugenia Ave.

Page, Willard D.—Vice-President and engineer, A. E. Finley and Associates, Inc., 3101 Hillsboro St., Raleigh, N. C.

Paine, Robert I.—Head of research and development, The McRan Co., 9999 Hempstead Rd., Houston 5, Tex.

Pangotra, Pushap N. — Chief instructor, Extension Training Centre, Nilokheri, Distt Karnal, India

Pearson, Robert F. — Agricultural engineer (SCS), USDA, Temple, Tex. (Mail) RR 2

Prendergast, Walter S.—Vice-President and general manager, Carlon Products Corp., 10225 Meech Ave., Cleveland 5, Ohio

Rear, Hugh J.—Sales representative, Wade Mfg. Co. (Mail) 94 N. Huron Ave., Columbus, Ohio

Richards, Jack M.—District manager, Elastic Stop Nut Corp. of America, 1791 Howard St., Chicago, Ill.

Ryker, Norman L. — Student in agricultural

(Continued on page 356)

HOW TO BUY AGRICULTURAL BELTING

for SPECIAL EQUIPMENT DESIGN PROBLEMS

. . . and get "More Use per Dollar"

The success of a new farm equipment design frequently depends on the efficient operation of the belted drives that run its intricate mechanism.

Look for a company whose engineers will work with you to design a power transmission drive as nearly foolproof as possible for your equipment . . . a company with a reputation for designing and manufacturing rubber belts to meet the most exacting requirements of leading farm equipment manufacturers.

Specify by name the Agricultural Belts made by a company with long experience and specific technology in farm equipment . . . specify Manhattan Agricultural Belts.

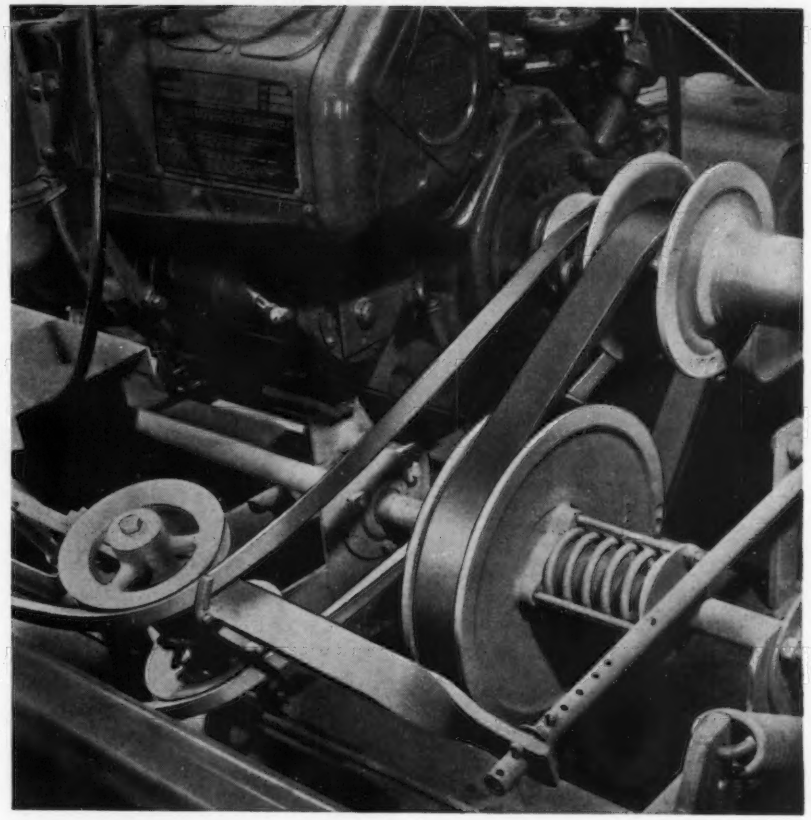


Photo courtesy Owatonna Manufacturing Co., Inc.

MANHATTAN AGRICULTURAL BELTS

At Manhattan, R/M engineers draw on more than 60 years of rubber technology and production experience to combine with the inventive genius of the equipment manufacturer to solve critical problems that may arise in the design of belted transmission drive problems. The variable speed drive for the center delivery self-propelled windrower shown above is a typical example. By working closely with the manufacturer, Manhattan engineers were able to assist in designing an efficient, dependable, trouble-free drive for this often difficult application. The engineered features of strength, flexibility and long-life built into the Manhattan Agricultural Belt designed for this drive helps account for its consistently uniform performance . . . its day-in, day-out dependability on the job. In all belted power applications, Manhattan Agricultural V-Belts, Condor Whipcord Endless Belts and Poly-V Drives are continually contributing to the success of new and existing farm equipment designs. Manhattan Agricultural Belts enable farm power equipment to perform at peak efficiency under all operating conditions and in all kinds of weather . . . thus furthering the good reputation of its manufacturer.

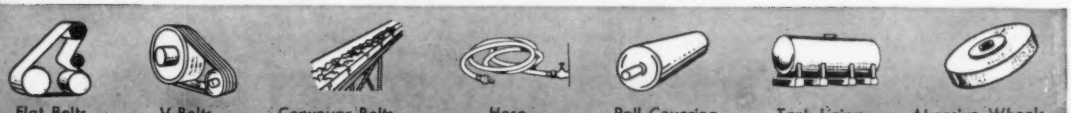
Let R/M engineers work with your engineering department to solve your belting problems. They can show you why Manhattan Agricultural Belts are the most reliable made today . . . how they add "More Use per Dollar" to the equipment they run.

RM-515

R/M

MANHATTAN RUBBER DIVISION—PASSAIC, NEW JERSEY

RAYBESTOS-MANHATTAN, INC.



Other R/M products include: Industrial Rubber • Fan Belts • Radiator Hose • Brake Linings • Brake Blocks • Clutch Facings • Asbestos Textiles • Packings • Engineered Plastic, and Sintered Metal Products • Bowling Balls

Applicants for Membership

(Continued from page 354)

engineering, Oklahoma A. & M. College. (Mail) 210 N. 10th St., Okemah, Okla.

Sharp, Aubrey L. — Hydraulic engineer (SCS), USDA. (Mail) Box 115, Willamette, Ore.

Simpson, Albert N. Jr.—Agricultural engineer (SCS), USDA, Upper Darby, Pa.

Stay, Samuel F.—Plant engineering, Lincoln Electric Co. (Mail) Pekin Rd., Novelty, Ohio

Trifkovich, Borislav — Engineer, Reynolds Metals Co. (Mail) 1020 W. 20th Place, Chicago 8, Ill.

Valdez, Zacarias V.—Head, agricultural engineering and service dept., National Merchandising Corp., PO Box 134, Manila, Philippines

Valentine, Robert G. — Regional product educational supervisor, Ferguson Div., Massey-Harris-Ferguson, Inc. (Mail) 4230 Twin Brooks Rd., Brookhaven, Ga.

Weber, Marvin D.—Sales engineer, Electric Wheel Co., Quincy, Ill.

Wessinger, Lucius C.—Division rural engineer, Georgia Power Co., 713 Broad St., Augusta, Ga.

Wognum, Willis S. — Vice-President, Helix Corp., N. Main St., Crown Point, Ind.

Transfer of Membership Grade

Gilden, Robert O.—Extension agricultural engineer, University of Wyoming, Laramie, Wyo. (Associate Member to Member)

Kitchen, Daniel A. — Senior engineer, National Safety Council, 425 N. Michigan Ave., Chicago 11, Ill. (Associate Member to Member)

Pristo, Ray E.—Advanced designer, International Harvester Co. (Mail) 1624 So. 56th Ave., Cicero, Ill. (Associate Member to Member)

Reeser, Lyle G.—Export training co-ordinator, export dept., Caterpillar Tractor Co., Peoria, Ill. (Associate Member to Member)

Rekken, G. M.—Director of research, Mutart Enterprises, Ltd., Box 310, Edmonton, Alta., Canada. (Associate Member to Member)

Shirley, LeRoy—District service supervisor, International Harvester Co., Memphis 4, Tenn. (Mail) 530 Summitt St. (Associate Member to Member)

Vahrenkamp, Robert H.—Assistant general manager and director of conservation, Guadalupe-Blanco River Authority, Seguin, Tex. (Mail) 615 E. Center St. (Associate Member to Member)

WISCONSIN-POWERED

John BEAN ROTOMIST

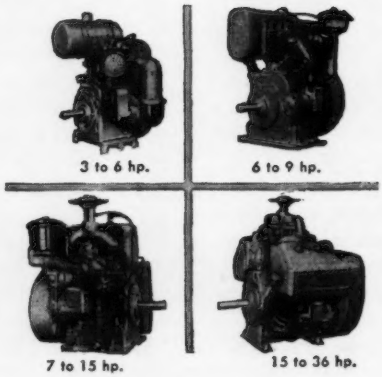
Delivers Accurate "On Target" Air Stream!

Power TO FIT THE JOB — Power TO FIT THE MACHINE

Delivering a powerful, "micronized spray" Air Stream right on the target and reaching into the tops of the tallest trees . . . that's the job that is being handled efficiently and economically by this John Bean "Rotomist Pest Control Concentrate Applicator" made by the John Bean Div., Food Machinery & Chemical Corp., Lansing, Mich. Both in the smallest and largest communities, controlling pests and diseases in shade and fruit trees is becoming an increasingly important operation that calls for the most modern type of mechanized equipment.

And a vitally important component of this equipment is the POWER UNIT . . . a Wisconsin Heavy-Duty Air-Cooled Engine. It provides the solid dependability and Inherent Lugging Power that *hangs on* and keeps the job moving. Tapered roller bearings at BOTH ends of the crankshaft assure smoothest running and protection against bearing failure. Foolproof AIR-COOLING at temperatures up to 140° F. provides efficient operation under all climatic conditions. Heavy-duty design and construction in all details adds the final measure to long engine life and low-cost maintenance . . . "Most H.P. Hours" of on-the-job service.

These are some of the reasons why leading builders and users of farm and orchard equipment specify "Wisconsin Power".



Wisconsin Heavy-Duty Air-Cooled Engines offer equipment designers, builders and users the greatest power *selectivity*, with maximum power advantage, without power waste. Available in 12 different models in 4-cycle single cylinder, 2- and V-type 4-cylinder sizes, from 3 to 36 hp. For continuous heavy-duty service, all models can be equipped with Stellite exhaust valves and valve seat inserts, positive valve rotators, and Automatic High Temperature Safety Switch can be installed on all multi-cylinder as well as larger single cylinder models.

WISCONSIN MOTOR CORPORATION

World's Largest Builders of Heavy-Duty Air-Cooled Engines

MILWAUKEE 46, WISCONSIN

A 8389-½-I

PERSONNEL SERVICE BULLETIN

NOTE: In this bulletin the following listings current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated.

POSITIONS OPEN—AUGUST—O-251-648, 244-649. SEPTEMBER—O-276-650, 262-651, 293-654. OCTOBER—O-326-656, 327-659, 353-660. NOVEMBER—O-374-661. 1955—JANUARY—O-434-666, 437-667, 438-668, 441-669, 447-672. FEBRUARY—O-2-702, 19-704, 32-705, 33-706, 44-707, 44-708, 18-709. MARCH—O-55-710, 56-711, 15-712, 61-713, 71-714, 87-715. APRIL—O-120-716, 142-717, 125-718, 155-719, 143-720, 173-721.

POSITIONS WANTED — AUGUST — W-237-142, 265-144. SEPTEMBER — W-246-147, 294-150. OCTOBER—W-296-152, 330-153, 340-154, 365-155, NOVEMBER — W-369-157, 372-159, 375-160. DECEMBER—W-400-161, 391-164, 409-165, 411-166. 1955 — JANUARY — W-429-168, 427-169. MARCH—W-17-2, 52-3, 48-4, 84-5, 27-6. APRIL—W-114-8, 129-9, 4-10, 133-11, 134-12, 131-13, 67-14.

NEW POSITIONS OPEN

AGRICULTURAL ENGINEERS qualified for and interested in graduate work. Research half-time positions open in all fields at midwestern agricultural experiment station. Positions may be combined to provide full-time support. Studies in tractor maintenance problems, silo filling equipment, silo unloading and silage feeding, materials handling from ground level and elevated storage, and runoff and drainage. BS deg in agricultural engineering or equivalent required. Opportunity for up to ½ to ¾-time graduate study on half-time positions. Salary $1,800 to $2,400 for half-time depending on experience and training. O-200-722

AGRICULTURAL ENGINEER to teach elementary agricultural engineering, agricultural machinery, farm shop, and farm buildings in a state college in the Midwest. Age 25-35. Ms deg or higher, in agricultural engineering or related field. Tractor and farm machinery repair experience desirable. Interest in teaching and a will to enlarge the shop work program. Excellent opportunity for man who will successfully complete advanced graduate work. Opening effective September 1. Salary $460 per month for MS deg and no experience. O-197-723

AGRICULTURAL ENGINEER to teach agricultural mechanics, farm structures, pumps and motors in a state college in the West. Age 25-35. BS deg in agricultural engineering and MS deg in agricultural engineering completed or in progress. Industrial and teaching experience desirable but not required. Must be able to demonstrate skills required in teaching field. Good opportunity for advancement. New shop facilities. Ten-month appointment, 12 monthly checks. Additional pay for summer school work. Opening effective September 1. Salary open. O-180-724

AGRICULTURAL ENGINEER for development engineering work on agricultural sprayers. Excellent opportunity with a century-old company in the East for an agricultural engineer with more than three years experience with pesticide equipment for orchard, row crops and weed control. Applicant should have a knowledge of the latest methods including concentrate application by boom and air blast.

(Continued on page 358)

BURLAP BULLETIN

News about packaging and agricultural and industrial developments in burlap

ANY OF THIS MATERIAL MAY BE REPRODUCED WITHOUT PERMISSION.

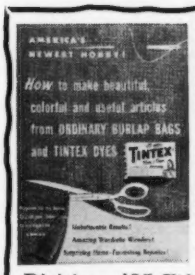
From Airfields To Irrigation

American agriculture will benefit from the development of an asphalt impregnated jute fabric which was evolved during the war for the construction of airfields in forward combat areas. The same principle is now being used in testing this material as an irrigation canal lining. If successful, it will greatly reduce irrigation costs. This lining should reduce seepage substantially and be tough enough to resist puncture from animal hoofs as well as other impact. A complete report on these experiments will appear in a future *Burlap Bulletin.*

Sampling the contents of a burlap bag is simple because small holes in the fabric close together of their own accord.

Golden Nematode May Change Snow Fence Construction

A new type of snow fence at about one third the cost of the conventional wooden snow fence is being tested to help control the spread of Golden Nematode on Long Island. Potato farmers there have objected to erecting conventional snow fences *from storage* on their property fearing the Nematode will be transmitted to their fields. A new fence of burlap, cheap enough to be discarded after one season, is now under test. Handling and removal costs should be lower, too. The highway superintendent of a Long Island town which uses 50 miles of snow fences estimates that he could save $20,000 annually by using such a disposable fence. Burlap snow fences should prove to be not only safer where soil contamination is a danger, but also more inexpensive to erect and remove.


AMERICA'S
NEWEST HOBBY!
How to make beautiful, colorful and useful articles from ORDINARY BURLAP BAGS and TINTEX DYES
TINTEX

Housewives and handicrafters can now make beautiful and useful articles out of used burlap bags by simply following the directions for dyeing found in this folder offered by Park & Tilford, Tintex Division, 485 Fifth Ave., New York 17, N. Y. The folder has many suggestions for clothing and home furnishings that can be made and gives step-by-step directions.

Farmer Co-Operatives Prefer Burlap

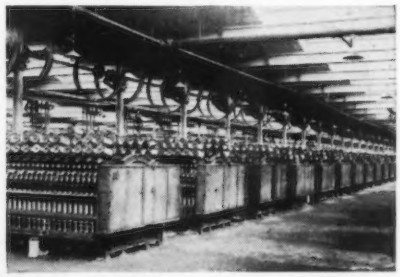
Recent surveys among cooperative feed mills show a 5 to 1 preference for burlap versus any other type of container for feed. The cooperatives have found that farmers prefer burlap because of its re-use and re-sale value. Over 71% of the cooperatives polled reported they prefer burlap for packing feed and 57% reported they pack feed in burlap only.

Saves Space. These stacks of dried beans in a Kansas City warehouse illustrate the fact that burlap bags can be stacked to any height without slipping, with a great saving of warehouse space.

New Tobacco Shade Cloth

Tobacco growers in the Connecticut valley who produce those fine leaves used for outer cigar wrappings may save thousands of dollars this year if a research project of the Burlap Council is successful. Shade-grown tobacco is now protected by cotton cloth which lasts only one year, and growers have been looking for a more durable fabric which, by reuse would reduce costs. In cooperation with the Imperial Agricultural Corporation, the Burlap Council has been testing a burlap shade cloth. Untreated burlap deteriorates from mildew and ultra violet light. However, burlap is much stronger than cotton and when treated, retains this strength advantage. If weathering tests of burlap now standing in the field prove successful, it will get a trial for shade tents with the Spring tobacco planting. If burlap lives up to expectations it will withstand storm damage and give an extra year of service.

Tobacco baling is another project in which the Imperial Agricultural Corporation engineers are cooperating with The Burlap Council. Shade-grown tobacco is now baled in Borneo mats imported from the Far East. If proved satisfactory, burlap will be more economical.



High Speed Spinning Frame Lines in a Calcutta mill. Extensive modern mills, employing latest mass-production techniques, assure American consumers of a continuous supply of burlap. Today, 85% of all the burlap used in this country is manufactured in Calcutta mills.

Attention Agricultural Leaders

The Indian Jute Mills Association seeks to serve American agriculture through its technical development program in this country. Conducted through the Burlap Council, this effort is supported by the Indian Jute Mills Association Research Institute in Calcutta and its full staff of scientific personnel with chemical, physical and biological laboratories.

Put them to work on any of the projects you may be interested in where there is a possibility that burlap might increase efficiency or economy. Write to William A. Nugent, Vice President, The Burlap Council, 155 East 44th Street, New York 17, N. Y.

Published by The Burlap Council of the Indian Jute Mills Association
155 East 44th Street, New York 17, N. Y.

Personnel Service Bulletin

(Continued from page 356)

Will be required to follow projects from design through field tests to final production. Arrangements for personal interview can be made after resume of background and experience is submitted. Salary open. O-196-725

AGRICULTURAL ENGINEER with farm background to represent a private agricultural engineering business in direct contacts with northern New England farmers. Should have desire and promotional ability to build business within engineering ethics, as well as ability to design, construct, and supervise in the fields of irrigation, crop drying, ventilation, materials handling, and structures. Salary open. O-205-726

AGRICULTURAL PRODUCT DESIGNERS. Responsibility for the layout and design of tractor and implement components such as engines, hydraulic systems, electrical circuits, planting and cultivating equipment, harvesting equipment and etc. Excellent opportunities and salary for experienced personnel. Midwestern location. Salary open. O-214-727

AGRICULTURAL PRODUCT ENGINEER. Develops engineering design of tractor components such as hydraulic systems, engine, axles, transmissions, electrical circuits, or implements such as planters, cultivators, grain drills, middle busters, harvesting equipment, etc. to obtain efficient operation and attain desired engineering objectives. Many of these positions carry supervisory ratings with salaries commensurate with experience and specific product development background. Midwest. Salary open. O-214-728

NEW POSITIONS WANTED

AGRICULTURAL ENGINEER for sales, service, development, or design in rural electrification or farm machinery in middle Atlantic States. Will travel some. To be married soon. Age 24. No disability. BS deg in agricultural engineering 1952, Virginia Polytechnic Institute. Rural background, with farm, construction, and personnel work in farm marketing. Enlisted and commissioned service in Corps of Engineers, with a total of 33 mo service on termination of present tour. Available June 1. Salary open. W-154-15

AGRICULTURAL ENGINEER for development, research, extension, or teaching in soil and water field, anywhere in U.S.A. Willing to travel. Single. Age 25. No disability. BS deg in agricultural engineering, 1951, Kansas State College. Expect to complete requirement for MS deg in irrigation engineering by July 1, Colorado A and M College. Farm background. Civil engineering work in office engineering division, U.S. Bureau of Reclamation, 6 mo. Army service 1½ yr, in research, design, and operation of an irrigation system. Available July 1. Salary open. W-165-16

AGRICULTURAL ENGINEER for design or development work in farm machinery field. Prefer Midsouth or Midwest location. Married. Age 28. BS deg in agricultural engineering, 1948, Iowa State College. Farm background. Employed past 6 years in design and testing of farm machinery by Midwestern farm machinery manufacturer. Available on reasonable notice. Salary open. W-177-17

AGRICULTURAL ENGINEER for full time research in power and machinery field, in public service, preferably in Southeast. Married, Age 26. No disability. BS deg in agricultural engineering, 1949, University of Georgia. MS deg in agricultural engineering, 1955, North Carolina State College. Farm background. Summer work experience in light construction, 1945-49. Irrigation engineer in South Georgia and North Florida, 1949-51. Enlisted service with Army Field Forces Board No 1, doing survey work, 1951-53. Research assistant on peanut mechanization, 1953 to present. Available July 1. Salary open. W-185-18

AGRICULTURAL ENGINEER for development or research in power and machinery field with industry or public service in West, Southwest, or foreign location. Married. Age 45. No disability. BS deg in agricultural engineering, 1953, California State Polytechnic College. Since December 1953, harvesting superintendent on sugar plantation in Hawaii. Previous experience 15 yr in diesel engine manufacture and operation. War service in Navy 2 yr as machinest mate. Available June 1. Salary $400-600 per mo. W-176-19

AGRICULTURAL ENGINEER for design, development, research, or teaching in power and machinery or product processing field with college, experiment station or manufacturer anywhere in U.S.A. Willing to travel. Married. Age 45. No disability. Graduate mechanical and electrical engineer 1932, University of Technology of Munich, Germany, Experience in development and testing of carburetor and diesel engines, gears and related testing equipment, 14 yr; chief design engineer of development and testing of tractors and agricultural equipment, in Munich, Germany, 5½ yr. Immigrated to U.S.A. in March 1955. Fair reading, speaking and writing knowledge of English and French. Available on reasonable notice. Salary open. W-193-20

AGRICULTURAL ENGINEER for teaching or research in farm structures field with college, experiment station or trade association anywhere in U.S.A. Married. Age 27. No disability. BS deg, 1951, Cornell University. MS deg in agricultural engineering with major in farm structures, 1952, Iowa State College. PhD in farm structures and civil engineering expected December 1955, Iowa State College. Dairy farm experience in New York State 15 mo. Part time undergraduate assistant in drafting and research, 2 yr. Research associate, Iowa State College, equivalent to 18 mo full time. Instructor in farm structures, Iowa State College, equivalent to 12 mo full time. Enlisted service in U.S. Signal Corps 13 mo in personnel classification. Available Jan. 1, 1956. Salary open. W-206-21

AGRICULTURAL ENGINEER for export or domestic sales work in power and machinery or product processing field with industry, anywhere in U.S.A. Married. Age 26. No disability. BS deg in agricultural engineering, 1951, Virginia Polytechnic Institute. Master's deg in business administration and industrial management expected in June, Wharton Graduate School, University of Pennsylvania. Horticultural work in peach and apple orchards, 6 summers. Commissioned service 2 yr in anti-aircraft artillery, radar officer and battery commander. Available June 15. Salary open. W-182-22

AGRICULTURAL ENGINEER for design, development, research or teaching in power and machinery or soil and water field, with industry or public service, any where in U.S.A.; other locations also considered. Single. Age 27. No. disability. BS deg in agricultural engineering, McGill University, 1951. MS deg in agricultural engineering, 1953, Durham University. Experience in tropical agriculture and manufacture of related equipment. Available on one month notice. Salary open. W-213-23

for precision

TeeJet®

World famous nozzles for boom and portable sprayers. Choice of over 400 interchangeable orifice tips in flat spray, cone and straight stream types. Write for Bulletin 58.

Patent No. 2,619,388

for broadcasting

BoomJet®

Spray up to 66 feet wide with one assembly. For spraying grains, grasses and liquid fertilizers. Write for Bulletins 66 and 71.

for gun spraying

GunJet®

Adjustable spray for pressures up to 800 lbs. Write for Bulletins 65 and 69.

SPRAYING SYSTEMS CO.

3226 Randolph Street • Bellwood, Illinois

May We Serve You?

You will find our experience in WHEEL IMPROVEMENT a treasure store for you in your search for MOBILITY at its BEST. We offer you—

DESIGN of WHEELS and HUBS

DESIGN of SPINDLES and AXLES

SELECTION of Adequate BEARINGS

SELECTION of Suitable Closure SEALS

SELECTION of Sizes, Types, Rubber TIRES

—in ONE Engineered Package

Our PACKAGE PLAN can save you Research, Development, Tooling Costs. We Invite Your Inquiries.

INTEGRATED ENGINEERING — WHEEL BUILDERS for AGRICULTURE & INDUSTRY — Since 1888

FRENCH & HECHT

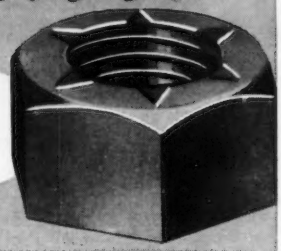
DIVISION

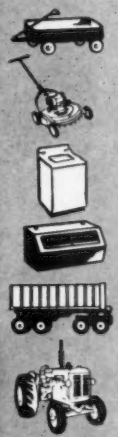
KELSEY-HAYES WHEEL COMPANY

DAVENPORT, IOWA

use a GRIPCO LOCK NUT

- To Hold Tighter
- To Last Longer
- To Cost Less





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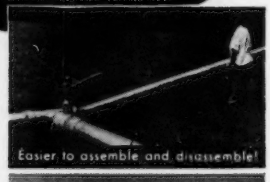
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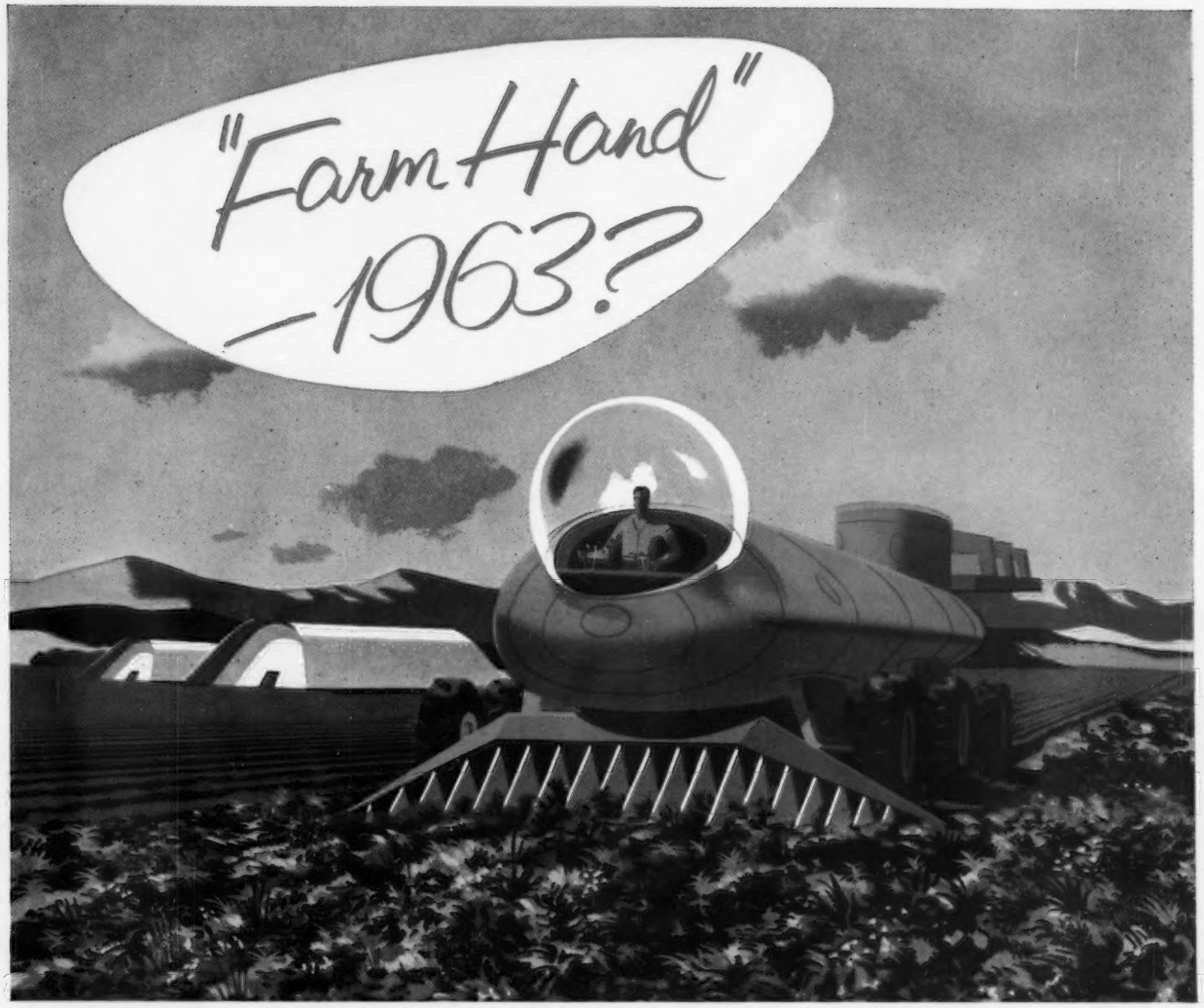

Today, New Departures are used by almost every manufacturer of farm equipment. That's because New Departure ball bearings have proved their ability to carry *all* loads, preserve accurate alignment of moving parts, cut friction and upkeep.

How you gonna keep 'em away from the farm after they've seen this machine? . . . Chances are, the people who develop this **soil-conditioner, fertilizer-planter unit,** with its air-conditioned control cab, will call on New Departure for ball bearings. Maybe they'll just need New Departures that are already in world-wide use—like the Sealed-for-Life or the double-row angular-contact ball bearings. Or they might want an entirely new type—a "new departure" in ball bearing design. Either way, New Departure is the answer. Manufacturers everywhere know that New Departure always lives up to its name—being *first* with the finest in ball bearings.

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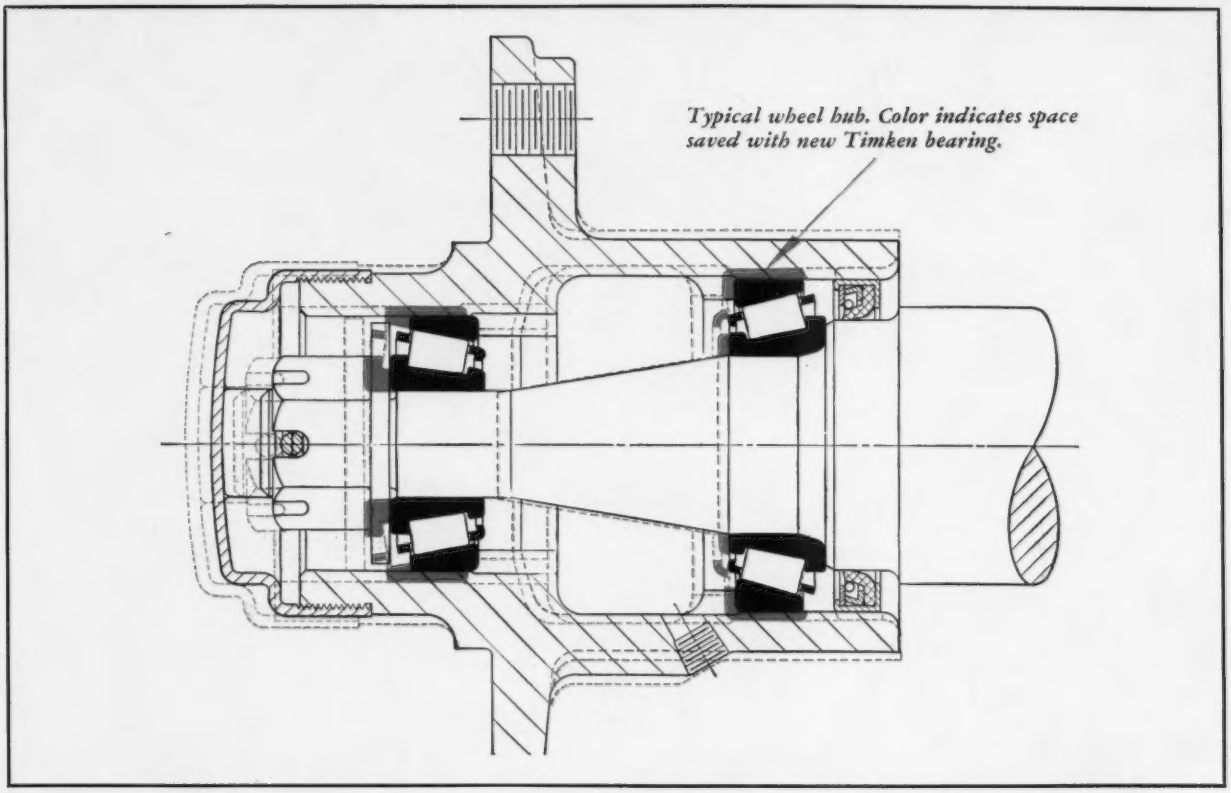
Three new TIMKEN® bearings cost less, permit savings in related parts, too



New capacity-packed bearings take up less space than previous designs of same bore sizes

THREE new Timken® tapered roller bearings are now available in bore sizes of ¾", 1¼" and 1⅜". And they cost less than previous bearings of the same bore sizes. Because they take up less space and weigh less, they permit application designs that save in related parts, too. And never has so much bearing capacity been packed into so little space.

These new Timken bearings offer exciting opportunities for savings through redesign of present tapered roller bearing applications. One example is shown in the above diagram of a typical wheel hub. Seals can be smaller and cheaper, hubs can require less metal and less machining, spindles can be made shorter and less costly to machine. All these savings are in addition to the lower cost of the bearings themselves.

Many engineers have already taken advantage of these possibilities and well over 1,000,000 of the new bearings are proving themselves in automobile front wheels and other applications.

The new Timken bearings also make it possible for you to enjoy the advantages of tapered roller bearings in many new applications—and at minimum cost.

Auxiliary parts for use with the new Timken bearings are available from the Timken Company and major closure manufacturers. For full information on the new low-cost Timken bearings and help in designing them into your product, write today to The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

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